Volume 2, Number 1
January, 1961

underwater engineering

The Magazine of ASW, USW and OCEANICS

1961 ASW SURVEY AN
SUBMARINE HYDRAULI
EVALUATION OF ASW

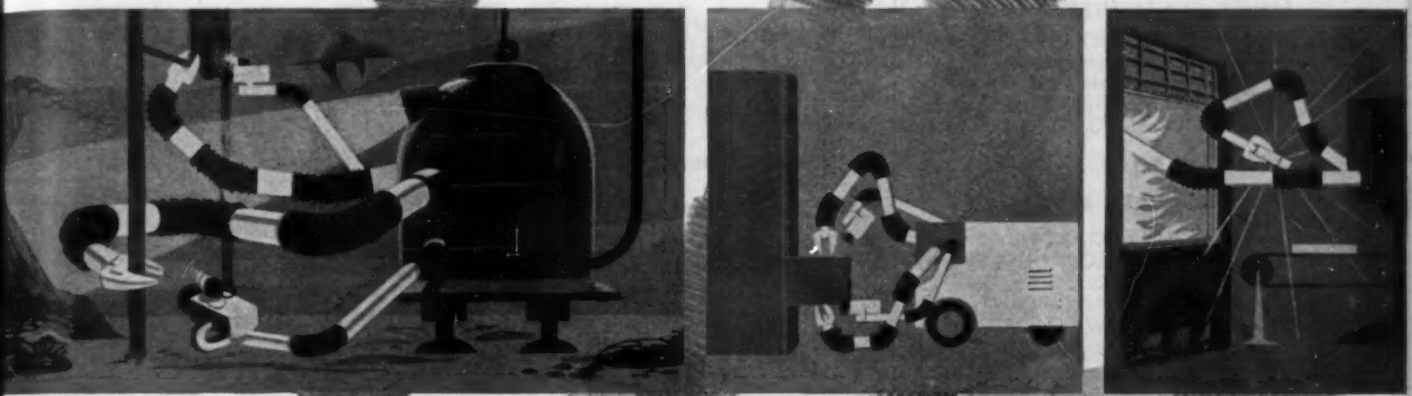
The new Hughes MOBOT* Mark 2 System offers new versatility for every remote handling requirement

Around, over and under, the Mark 2 Arm reaches the hard to get at places. Superior to any other remote controlled arm, the Mark 2 will move 180 degrees in any direction at each of three joints; the wrist will rotate continuously in either direction. Hand telescopes 3-1/2 inches. The Mark 2 Arm is five feet long and will lift 25 lbs. while the arm is in any position. It can be mounted on a wall, pole, boom or remote controlled vehicle.

The modules making up the electro-mechanical MOBOT Mark 2 System—Mark 2 Arm (or Arms), Television System, Command System—can be custom combined to meet your exact requirements. Buy only the capabilities you need.

The versatility of the system, the flexibility of the arm, and the ability to perform reliably in almost any environment, make the MOBOT Mark 2 System ideal for use in "hot" cells, reactor maintenance and repair, underwater construction or salvage, fire fighting or automating any dangerous or tedious manufacturing operation. *Trademark of H.A.C.

For firm price and delivery dates, or for engineering assistance with your remote handling requirement, contact: HUGHES NUCLEAR ELECTRONICS LABORATORY, P.O. Box 90915, Los Angeles 45, Calif., TWX INGL 4036, ORchard 0-1515, Ext. 4355.



NOW...more freedom of movement than the human arm

CREATING A NEW WORLD WITH ELECTRONICS

HUGHES

HUGHES AIRCRAFT COMPANY
NUCLEAR ELECTRONICS LABORATORY

Circle Reply Card No. 2

underwater engineering

Published by Sheffield Publishing Co., Inc.

Accepted as a controlled circulation publication at Shepherdsville, Kentucky.

Printed in Shepherdsville by Publishers Printing Co.

Published bi-monthly.
640 Washington Bldg.,
Washington 5, D. C.
DIstrict 7-8570

Vol. 2, No. 1 January 15, 1961

PICTURE CREDITS: Cover: HUGHES AIRCRAFT CO.; pp 21-31, U.S. NAVY and ELECTRIC BOAT DIV. of General Dynamics Corp.; pp 36-40, SPARTON ELECTRONICS; pp 42-44, MINNEAPOLIS-HONEYWELL REGULATOR CO.; pp 46-48, U.S. NAVY.

cover

Three-dimensional information—range, bearing, altitude—on many aircraft is displayed on these scopes in combat information center of missile cruiser *USS Galveston*. Target bearing is shown on plan position indicator, left, and range and height on scope at right. Displays are part of Frescan radar system developed for Navy by Hughes Aircraft Co. Story and chart are on page 50.

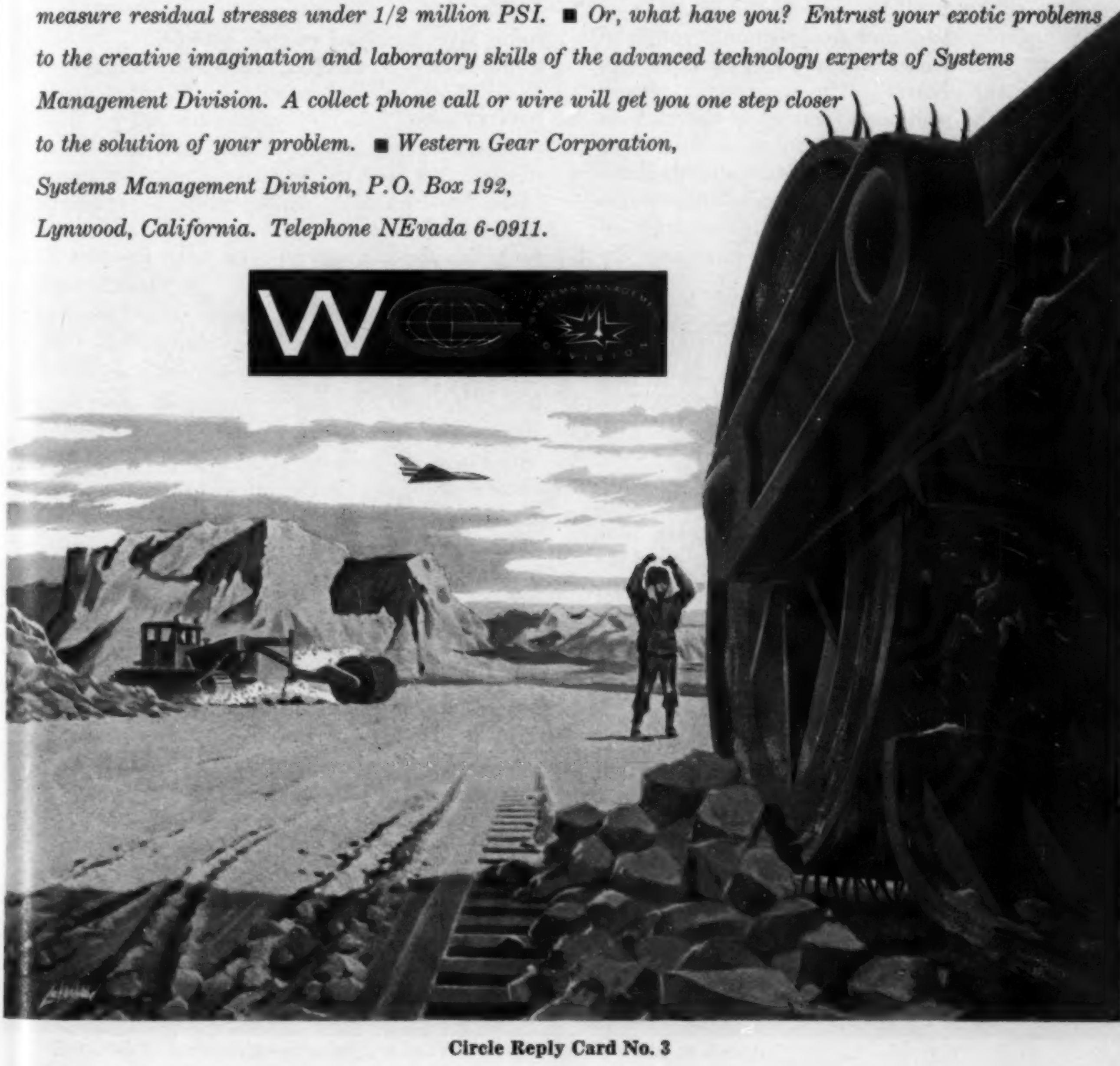
★ ★

circulation & subscription

NOTE—Underwater Engineering circulation is executed on a controlled unpaid basis. Engineering and management personnel actively engaged in the areas of undersea warfare and oceanography are considered qualified applicants. Use the self-addressed post card in this issue or write to Circulation Dept., 2775 S. Moreland Blvd., Cleveland, Ohio.

"HOW TO" IS OUR ONLY PRODUCT!

How to find economical and practical answers to exotic problems is the 24-hour-a-day job of the advanced technologists of Systems Management Division, Western Gear Corporation. ■ *Look at these recent proposals prepared by Systems Management Division:* **HOW TO** *level mountains of ice to make airport runways.* **HOW TO** *collect and return lunar soil samples for analysis.* **HOW TO** *stabilize a submarine to provide a missile-firing platform.* **HOW TO** *devise a power transmission system for a high-speed, ocean-going hydrofoil craft.* **HOW TO** *transmit high HP and high speed by other than present known methods.* **HOW TO** *use plasma flame technique to produce self-supporting shapes from refractory metals such as small tungsten tubing and nozzle inserts.* **HOW TO** *build multi-frequency resonant antennae without loading coils.* **HOW TO** *operate gears in radiation atmosphere at high temperatures without lubrication.* **HOW TO** *use new techniques in measuring jet engine temperatures.* **HOW TO** *televise and photograph ocean bottom at 500 fathoms.* **HOW TO** *measure residual stresses under 1/2 million PSI.* ■ *Or, what have you? Entrust your exotic problems to the creative imagination and laboratory skills of the advanced technology experts of Systems Management Division. A collect phone call or wire will get you one step closer to the solution of your problem.* ■ *Western Gear Corporation, Systems Management Division, P.O. Box 192, Lynwood, California. Telephone NEvada 6-0911.*



Circle Reply Card No. 3

editorial ★★★★★★★★★★★★★★★★★★★★★★★★★★★★★★

is there room for one more?

The interest focused on anti-submarine warfare, undersea warfare, and oceanography is a matter of perpetual growth, and we feel that it will continue to climb for quite a while yet before it levels off. This interest is being expressed in many different ways, from the initiation of new and sophisticated weapon system concepts all the way to the creation of new organizations and professional groups to support the various endeavors. The latest appeal for the creation of a professional group to handle the problems relating to the various aspects of underwater technology comes from the American Society of Mechanical Engineering and its aim is "to advance underwater technology and to provide for exchange of information among mechanical engineers involved in this work."

There are only two kinds of organizations, the "good" ones and the "no good" ones.

Let us make one thing clear right away: our purpose is not to try to hamper ASME's attempt to form a professional group. However, we are, through bitter experience, rather leary when it comes to the formation of new organizations, groups, institutes, or whatever they are called. Industry management has over the last couple of years started to react violently to the excess of organizations, and we can only agree that in many cases the interest motivating these organizations is being spread so thin that it covers nothing.

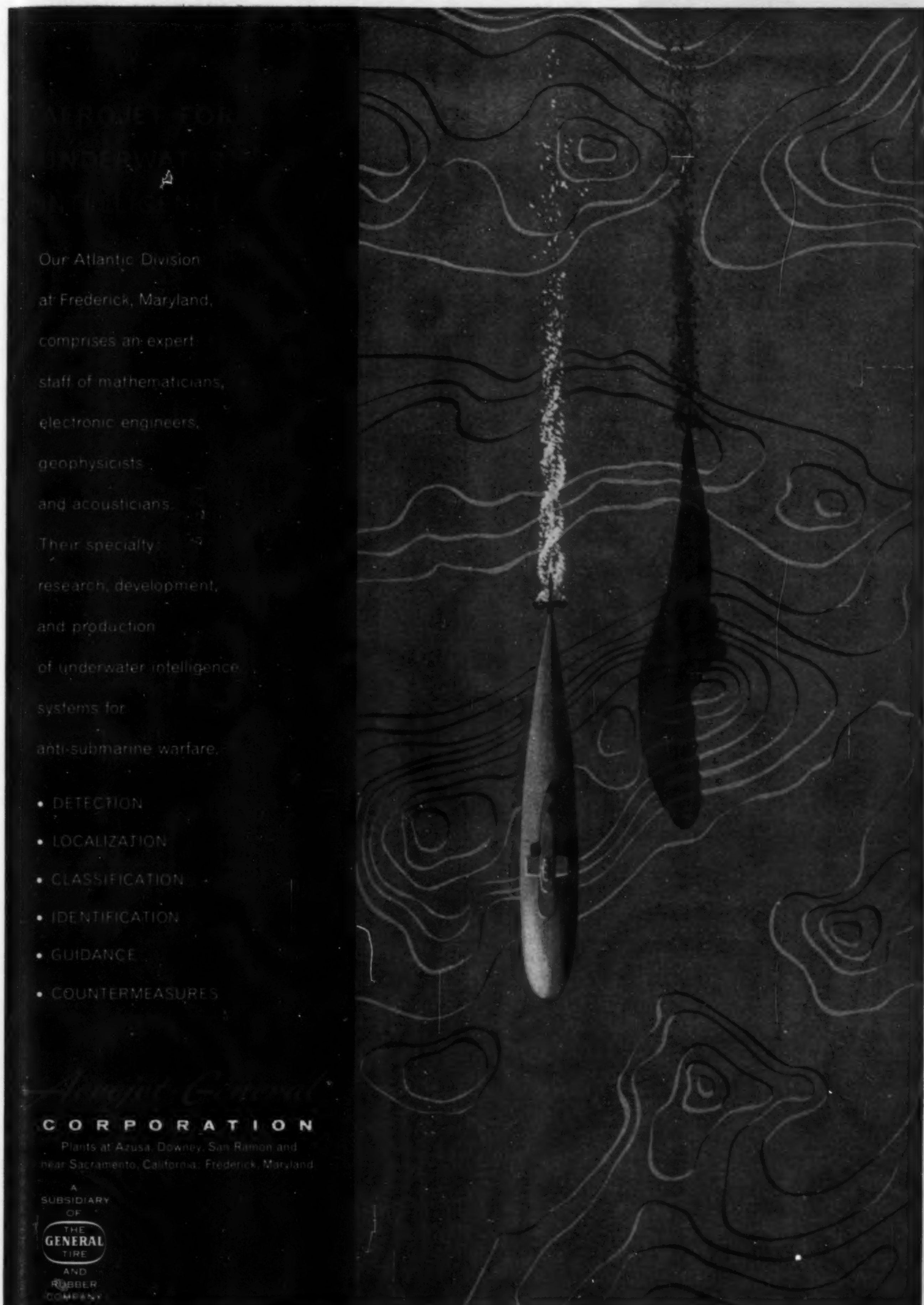
As a result, industry is taking a more and more skeptical look at participating in the functions sponsored by the professional and/or trade societies.

From management's point of view there is too much pressure from the various organizations for exhibits, hospitality suites, financial support of cocktail parties, luncheons, dinners, etc.etc.etc.etc.etc.etc. And there is also the matter of lost man hours of the "company representatives" attending these functions. An example is one leading electronic company which at one society meeting in 1959 had some five hundred people attending. At the same society's meeting in 1960, one West Coast company had more than 70 staff members present. This is completely out of line, especially when one considers that the funds needed to cover these activities are in many cases "written off" against some government contract. This means, of course, that in the long run the taxpayer is left with the tab. If the individual attendee and the participating industries gain something that can be applied towards the improvement of our national defense efforts, we do not mind picking up this bill. However, we have witnessed time and time again that many of the get-togethers of our national societies and associations turn into nothing but social affairs. On the other hand, we have also witnessed many conventions yielding positive benefits to the participants.

We think there is room for a professional group in the underwater technology field and, provided the American Society of Mechanical Engineers proposed organization is to be operated within the framework of the objectives of the mother society, we will sponsor and support it 100 per cent.

If it is to become another "country club," we want no part of it.

Peer Fossen



Engineers, scientists—investigate outstanding opportunities at Aerojet.

capital report ★★★★★★

By Paul Means

Both good and bad news are spelled by the outgoing Eisenhower Administration's budget figures for Fiscal Year 1962 and the incoming Kennedy Administration's revisions of them.

Ike's last budget gives the Navy approximately $12.2 billion — about $30 million less than they got in the FY '61 budget. Funding for the POLARIS fleet ballistic missile program levels off in the proposed '62 budget, while funds are cut off for the MISSILEER aircraft, aerial platform for long range air-to-air EAGLE missile.

Chances that budget figures for POLARIS and FBM submarines will be increased by the Kennedy Administration are excellent. POLARIS has developed into the nation's prime deterrent weapon system, and the new President has said he believes the nation's ability to defend itself is the primary consideration.

The Kennedy Administration may try to increase defense spending by two methods: increasing this year's (FY '61) budget by urging Congress to pass a supplementary appropriation; and by increasing the Eisenhower figures in the upcoming budget. It must be remembered that, as a Senator, Kennedy supported the Senate move to increase the FY '61 budget by $1.3 billion, some of which was to have accelerated the POLARIS program. As President, he may try again to add this money to the present budget.

Estimates of how much the Kennedy Administration wants to increase the Eisenhower Administration's FY '62 defense spending figures range from $2 billion to $5 billion. Included in these funds would be money for POLARIS and nuclear submarines.

But the Navy also needs funds for its fight to keep the surface fleet from becoming obsolescent. How much additional money the new Administration is willing to give them for this purpose remains to be seen.

• • •

Another contemplated move by the Kennedy Administration of great interest to Navy personnel is the plan to reorganize the Pentagon. Navy leaders, through the Navy League, have expressed considerable concern about plans to eliminate many service functions and to establish integrated and unified commands under the Secretary of Defense. This could mean, certain Navy spokesmen fear, that the Navy could lose direct control over its POLARIS submarines to the Air Force, if all strategic weapon systems were merged into one unified command.

The key to the new Administration's thinking about defense reorganization is in the recommendations submitted to Kennedy by a committee headed by Sen. Stuart S. Symington (D.-Mo.) last December. These recommendations included not only the integration of separate service commands, but also elimination of the service secretary posts and substitution of a single Chief of Staff for the Joint Chiefs of Staff.

Under the proposal to rely on unified, functional commands, all units of the strategic forces (the Strategic Air Command and the Fleet Ballistic Missile command) would unite under one command. This does not mean that the POLARIS submarines or SAC would be transferred out of their respective services, but that one commander, be he Air Force or Navy, would be in command.

• • •

Many Navy leaders rely on the traditional support their service has received from Congress to alter the effect of any reorganization bill tending to undermine the Navy's independence or position. But the power of the President is so great that he can effect much of his plan without going to Congress. He can, without enabling legislation, make mandatory a single overall war plan — he can command that the services tailor their budgets to meet the war plan. He can withhold funds appropriated by Congress, and can require the establishment of integrated, unified commands.

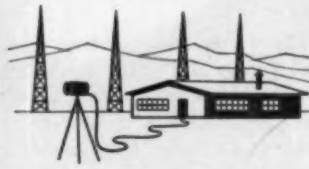
All that can be said with certainty is that significant changes will be effected in DOD structure, and that Navy leaders should prepare for them.

• • •

A New Look at VARIAN'S MAGNETOMETER FAMILY

The "Proton Free Precession" types find diverse applications; an "Optical Pumping" instrument extends research capabilities.

The simplicity, ruggedness and absolute accuracy made possible by Russell Varian's "Proton Free Precession" concept has made proton magnetometers the world standard in less than a decade. Using this principle, total magnetic intensities are quickly measured, without critical orientation or calibration requirements. Recent application of the "Optical Pumping" concept has enabled Varian Associates to develop a rubidium vapor magnetometer, with the highest sensitivity available today. This new instrument measures total magnetic intensities on a continuous basis.



OBSERVATORY

Varian's V-4931 Modular Station Magnetometer (proton) is a highly versatile and accurate monitor of the earth's magnetic field. Strip-chart analog records and digital readout are supplemented by printed-tape output which may be engaged, as desired, to provide permanent digital records. The V-4934 Station Magnetometer (rubidium vapor) is particularly suitable for measuring and recording geomagnetic micropulsations.

PORTABLE

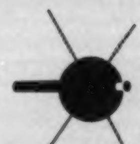
The Varian M-49, a complete proton magnetometer weighing less than 20 lbs., furnishes direct readings in gammas every six seconds. Sensitive to better than ±10 gammas, it requires no calibration or levelling and is so versatile it can make equally accurate field records from surveys on land, in the air, or over water. Eight plug-in tuner ranges, equally spaced from 19,000 to 101,000 gammas, allow operation throughout the world.

AIRBORNE

The V-4914 Airborne Magnetometer (proton) is a rugged, lightweight and compact version of Varian's Station Magnetometer. Sensitivity and accuracy are of observatory quality. Coarse- and fine-scale strip-chart records may be supplemented with punched-tape. The virtually indestructible "bird" contains no mechanical or electronic parts. Varian's V-4914 is easily accommodated in single-engined aircraft. Range: 22,500 to 73,400 gammas.

OCEANOGRAPHIC

An accessory "fish" towed up to five hundred feet astern of the hydrographic vessel is the sensing adjunct to Varian's V-4931 for oceanographic survey work. Suitable for broad-scale undersea mapping or offshore geophysical exploration, it furnishes information of observatory quality. Analog and digital readout and records, accuracy and operating range are identical to the observatory model.



RESEARCH

Examples of current projects in Varian's research and engineering laboratories include proton and rubidium vapor miniaturized magnetometers stressed for missile, satellite, and deep-space applications and instruments being developed for specific military applications, such as ASW. Varian's practical contributions to magnetometry are continuing to advance the state of the art.

For further information on magnetometer sales or leases in many countries of the free world — For loan of the Varian 16 mm color and sound movie on proton magnetometry — For copies of Varian's new Geophysics Technical Memorandum Series — call, wire or write Instrument Division

VARIAN associates

PALO ALTO 66, CALIFORNIA

NMR & EPR SPECTROMETERS, MAGNETS, FLUXMETERS, GRAPHIC RECORDERS, MAGNETOMETERS, MICROWAVE TUBES, MICROWAVE SYSTEM COMPONENTS, HIGH VACUUM EQUIPMENT, LINEAR ACCELERATORS, RESEARCH AND DEVELOPMENT SERVICES

Circle Reply Card No. 6

shipways

By William O. Foss

Cost of Navy's shipbuilding and conversion program for fiscal year 1961 exceeds $1,621,000,000 and, based upon past performances, will probably be higher in fiscal year 1962.

This brings up the question: Is Navy getting a fair return for its shipbuilding dollar?

The Navy can explain that creeping inflation at the rate of two to three per cent a year has got a stranglehold on its shipbuilding, conversion, repair, and alteration program. It can cite Bureau of Labor statistics which show that the shipbuilding index has risen 31 per cent since 1953, whereas the wholesale price index has risen only 13 per cent.

Furthermore, along with stringent budget levels, Navy has had to cut some ships from its building programs because of increase in prices of those already building and converting.

Unless the situation is corrected, not only Navy, but the entire American shipbuilding industry will suffer.

Fortunately, Navy has finally recognized the awful truth and, under a dollar-stretching program championed by Rear Admiral Ralph K. James, Chief of the Bureau of Ships, the service is now trying to find less costly ways of building and repairing ships.

These are steps in the right direction, but are they enough to stem the upward surge of ship cost?

Despite Navy's economy measures, the historical fact remains that work done in government industries is more costly than that performed in private industries.

Navy certainly recognizes the economic advantage of having ships built in private yards. Witness the recent awarding of a carrier construction contract to Newport News Shipbuilding and Dry Dock Co.

Navy said that a cost analysis of construction costs in naval and private shipyards was a "paramount factor" in the decision to award construction of the carrier to a private shipyard. Carrier construction bid proposal received from the Newport News company was more than $40,000,000 below Navy's estimate for building the ship in a naval yard.

For this reason, the public has the right to demand that a fair portion of Navy's shipyard work — not only new ships, but also repairs, overhauls, and conversion jobs — be done by private industry.

Congress may want to look into possibility of amending the Vinson-Trammell Act of March 27, 1934, so that private and government yards will have an equal chance to bid on all new Navy ship contracts. Law now splits new Navy construction jobs 50-50 between naval shipyards and commercial yards.

Another area in which Navy can really practice good economics is in ship overhauls, repairs, and conversions. Only about 16 per cent of such work is performed in private shipyards. Commercial yards should have more of this work.

The Shipbuilders Council of America is now making an exhaustive study of modern economics as applied to shipbuilding and ship repairing industry. The Council is prepared to show both Navy and Congress how to get more mileage out of tax dollars for construction, repair, alteration, and conversion of naval vessels.

It behooves Congress to make a serious study of these problems before it approves future Navy shipbuilding programs.

There is no question that both naval shipyards and commercial yards turn out good fighting ships. Question of the hour is not who can build the better ship, or who can do the best repair or conversion job, but who can do the best job for the least amount of money.

LETTERS TO THE EDITOR

To The Editor:

As a follow-up to one of the items in the "underwater sidelights" column of September 15 in Underwater Engineering, I thought you might be interested in the enclosed release about a nuclear power plant we are building for installation at McMurdo Sound.

It may be a matter of semantics, but I would also take issue with your statement that PM-1 is not prepackaged. While it is true that only one of the packages will be shipped in a container which can serve as housing for the unit, the power plant is what has generally been referred to as a "packaged" system.

Joseph M. Dukert
Manager of Information Services
Nuclear Div.
The Martin Co.
Baltimore 3, Md.

Mr. Dukert is quite right, this is a matter of semantics, considering the size of PM-1 and the manner in which it will be shipped. However, Underwater Engineering cheerfully admits that the weight of evidence is on Mr. Dukert's side. —Ed.

To The Editor:

Thank you for placing my name on your mailing list. I would greatly appreciate copies of the first two numbers.

You have an excellent magazine, but I would like to question the word *oceanics* that appears on the cover of volume 1, number 3. This word is completely new and meaningless, so far as I am concerned. If it refers to "oceanography" or "oceanology", why not use this word? If it was coined by your staff to include "oceanography" and "marine" or "submarine engineering", then why not use these terms instead of making up a new word that logically is unsuitable?

The unabridged 1960, 2nd Edition of *Websters New Int'l Dictionary,* has the following definition:

- *Oceanian* — of or pertaining to Oceania, or its inhabitants. A member of one of the native races of Oceania.
- *Oceanic* — of or pertaining to the ocean; found in or about, or produced by, the ocean; frequent-

ly the ocean, especially mid-ocean, pelagic. Oceanian.

- *Oceanid* — (Myth) An ocean nymph. The nymphs, 3000 in number, were daughters of Oceanus and Tethys.
- *Oceanity* — (Meteorology) — State or quality characteristic of a marine climate.

It *does not* list the word *oceanics*.

Russian oceanographers have long used the name *oceanology* in place of *oceanography*, which literally means ocean-study, or science of the ocean and there has been considerable discussion on which of these terms to use. (See "Deep-Sea Research", V. 2, p. 160, 247, 285; V. 4, p. 70).

Please do not further confuse the issue by introducing the term "*oceanics*" — we already have enough problems in terminology without adding still another term. If you saw this word in print elsewhere and have seen fit to use it in your publication, let me assure you, the word is not in wide use by oceanographers.

R. D. Terry
Autonetics
A Division of North American Aviation, Inc.
21617 Paul Avenue
Torrance, Calif.

The word "oceanics" was indeed coined by Underwater Engineering Magazine editors, just as the now familiar and much used terms "avionics" and "astrionics" were coined by other magazine editors. We intend to use it. —Ed.

To The Editor:

I would like to call your attention to Table I (page 50) of the article "The Coming Breakthrough in Underwater Propulsion" in Vol. 1, No. 2 of Underwater Engineering.

This article infers that these are the only model tow tanks in the U.S.A., or were these meant to be those along the Eastern seaboard only? There are many other towing tanks in the United States. In particular, we have here at Convair one that is 300 ft long, 12 ft wide, and 6 ft deep with one of the highest speed and acceleration capabilities of any of the model towing tank test facilities.

H. E. Brooke
Chief of Hydrodynamics
CONVAIR
A Div. of General Dynamics Corp. (San Diego)

The table as it appeared was obtained from U. S. Navy and lists only Navy and university installations, including several non-East

Coast tanks. We realize that there are many industrial tanks all over the United States. However, detailed information has not been available in all cases. —*Ed.*

To The Editor:

In the article "Torpedoes and Underwater Rockets" by Barron Kemp appearing in the second issue of Underwater Engineering, you discussed a single flexible-tail-fin boat driven by leg power which was used in Burma during World War II.

In my former job as Head of Boat and Small Craft Design in the Bureau of Ships, I heard of the use of this means of propulsion through intelligence reports. I was never actually able to run the reports down or get anything definite on this means of propulsion. Since this is of considerable academic interest to me, I wonder if you could furnish me with any source of material on the subject. I understood that those used in Burma were long flexible boards, but that was the extent of the information I acquired. I would certainly appreciate anything further you might have on the subject.

R. A. Fyfe, Head
Engineering Support Division
U.S. Navy Mine Defense Lab.
Panama City, Fla.

The author has few details on the leg-power-driven boat mentioned in his article. This craft was mentioned by H. E. Saunders in a paper presented before the Chesapeake Section of the Society of Naval Architects and Marine Engineers on 3 May 1951.

You can probably get a photocopy of the paper from the Society. Also, we think that there is a copy in the library at NOTS, China Lake, California. There is almost certainly a copy in the library at the Academy. —*Ed.*

To The Editor:

Recently I received the third issue and my first copy of Underwater Engineering. Congratulations certainly are in order for the quality of your publication. I would be grateful if you would please send me a copy of the first two issues which I missed.

Adrian F. Richards
Research Associate
U.S. Navy Electronics Laboratory
San Diego 52, Calif.

As announced elsewhere in this issue, we regret that our supply of back issues for Underwater Engineering magazine is completely exhausted. —*Ed.*

underwater sidelights

By E. E. Halmos, Jr.

Don't look for any major changes in organization for ASW work, despite all the talk about reorganization at the Pentagon that fills Washington as a new Congress and new Administration begin to take hold. Certainly there will be changes in Department of Defense, and many efforts to get things moving faster.

It is one of the changes reportedly recommended to President Kennedy that has caused the excitement over ASW — a committee report that is supposed to call for establishment of a separate agency to speed development of modern weapons, and the associated research that goes with this phase.

As a corollary to this suggestion, arguments have been advanced for establishment of some sort of "single manager" concept for Navy's ASW planning, procurement, and operation. It would eliminate the present setup, wherein a Navy ASW Committee (composed of the SecNavy, CNO, Asst. SecNavy for R and D, the various deputy chiefs of naval operations, intelligence, etc.) acts as a sounding board and reference point for ASW ideas and problems.

The Navy command gives strong evidence it will fight changes. Top braid believes that present organization (even though it appears cumbersome and multi-headed) takes cognizance of the fact that ASW is an operating force — in addition to being a development concept — thus can not be run by any single-manager organization. ASW forces, in fact, constitute about half the total Naval force, spread all over the world.

• • •

If you are one of the many who have been speculating as to the exact nature of Navy's "PROJECT ARTEMIS," here is a hint (from a paper prepared by the Office of the Assistant Secretary of the Navy for R and D): an exploratory effort to determine feasibility of . . . very high powered sonar transducers and high-gain receivers, with data processing equipment . . . for detection and tracking of submersibles at very long range.

• • •

It is not widely known, but the Navy has a new unit now functioning in the middle of one of the biggest Army camps in the U.S.: Fort Belvoir, Va., home of the Army's Corps of Engineers. The Navy unit, is, officially, the U.S. Naval Nuclear Power Unit, and its job is to coordinate plans with the Army and Air Force for use of nuclear power in remote corners of the world.

• • •

National Academy of Science is another area that underwater contractors should study. Reason: If any of the numerous bills calling for much-expanded oceanographic research go through Congress this year (seemingly a sure bet), NAS will administer the program, handle part of the financing itself. Total program as proposed last year would run to more than $60 million a year over a 10-year period, and would call for much that is new in the way of sounding devices, ships, etc.

• • •

First step in the long-planned PROJECT MOHOLE will be taken in March, near Guadalupe Island, off the western coast of Mexico, when a California firm begins experimental drilling at a depth of 12,000 ft of water. The work, under a $735,750 contract, is a preliminary to permit the National Science Foundation—National Research Council—to study techniques proposed by the contractor, Global Marine Exploration Co. of Los Angeles. The actual MOHOLE will probably be drilled off Puerto Rico a year or so from now. A problem arises from the fact that the deepest water in which such drilling has been attempted previously—from a floating, drilling barge—has been about 400 ft; thus, methods of mooring the barge in 12,000 ft of water are of particular interest.

• • •

Recognition of underwater operations as a special scientific branch may result from action now being pushed by the American Society of Mechanical Engineers. ASME is circulating questionnaires to its members, asking their opinion on formation of a professional group on underwater technology, under ASME's wing.

• • •

If you want a good idea of the kind of money that is going into ASW work, take a look at these figures — skimmed off the top of Navy appropriations: Bureau of Ships (which builds everything but the weapons) has an annual spending program of more than $3 billion; Navy, to date, has invested (including that recent contract to Lockheed's Missile and Space Division) $2.9 billion in POLARIS alone.

• • •

CAPABILITIES FOR DEFENSE . . .

Sounds of ignition and rocket thrust of POLARIS missile are almost inaudible in a submerged sub. A feature of an educational display at the Chicago Museum of Science and Industry is recorded countdown and launch sounds of the first underwater launch of the POLARIS from the USS *George Washington*.

• • •

Deep dives are shaping up. The Swiss *Hans Keller* has simulated a manned dive to a depth of 800 ft and was subjected to a pressure of 25 atmospheres. The tests were carried out at Toulon, France and maximum pressures were attained in nine minutes and took only 48 minutes to decompress. Light gases in place of regular oxygen mixtures are said to be responsible for the new technique.

• • •

Odd platform for making dives was described recently by Cdr. Jacques-Yves Cousteau. The craft provides a stable vessel in rolling seas and consists of large aluminum pipes covered by an envelope of nylon and neoprene. Inside the envelope are scattered innertube-type floats. The entire thing is then inflated with air. The ship was sponsored by Princess Grace of Monaco and was launched in mid-December. (The big problem in launching was how to break the bottle of champagne over it.) The weird craft holds a saucer-shaped diving device which is designed to work below 150 meters. The diving bell really resembles a "flying saucer" and is complete with Plexiglas portholes, rectractable camera and spotlight, and waving arms which are used to house water-squirting nozzles for movement and control underwater. Shades of the squid!

• • •

Seeking out sub periscopes and snorkel tubes is the job of a helicopter radar system under development by Bendix Corp. at North Hollywood, Calif. The Bendix-Pacific division will produce two prototype surface search-navigation radar systems for Navy's Sikorsky HSS-2 helicopters. The radar will boost the HSS-2 weapon systems ASW capabilities by pinpointing any portion of a submarine showing above the sea's surface.

• • •

Advancement in the Soviet Navy is pretty much dependent on whom your parents might be, the school you went to, or whether a billet is open at the command at which you might be stationed. Shore duty is for a special corps. The sons of wealthy or influential parents and of higher-ranking officers in the Soviet armed forces are assured of officer careers by attending military or naval prep schools. These facts were released in a Summer 1960 issue of the US Naval Training Bulletin.

• • •

POLARIS sub tender *Proteus* has undergone massive conversion and is now 44 ft longer than before. The ship is capable of any repair or replacement — short of complete overhaul — for a fleet of POLARIS subs. Unique features of the tender include a giant bridge crane to handle the IRBM, a four deck storage area for 20 missiles, a 120-ton container to store nuclear waste and a $5 million navigational system repair center.

• • •

Underwater propulsion system using water reactive fuels such as sodium or lithium was reported at the recent American Rocket Society meeting held in Washington by W. D. White, US Naval Ordnance Test Station, Pasadena, Calif. A unit, delivering 400-600 jet horsepower, was tested. Fuel consumption of 1.5 pound for each shaft hp-hr is to be possible. Incidentally, it seems that Jules Verne thought of the idea in 1865 for propulsion of the "Nautilus" of "20,000 Leagues Under the Sea" fame. However, it remained for the Navy to develop handling techniques and the achievement of a 95 per cent combustion efficiency.

• • •

Anti-sub sonar Navy contract has been awarded Bendix-Pacific. Over $3 million will be the tab for the transducer system, officially termed SQA-23. The additional systems ordered by Bureau of Ships will be used aboard ASW surface vessels.

• • •

Passive silent underwater detection system contract for $4.5 million has been awarded to Sperry and will be under the direction of the Naval Ordnance Lab. The accurate and wide range system is compatible with existing fire control equipment and is scheduled for installation in operational subs as well as those under construction.

• • •

engineering notes

By Alfred J. Zaehringer

underwater engineering

Vol. 2, No. 1 January, 1961

submarine hydraulics primary need:

greater share of r&d funds

By William O. Foss

The hydraulic system — often called the heart, the arteries, and muscle power of the submarine — needs more work to reduce structural and fluid borne noise generated by it. To do this Navy requires more research and development money, something which has been sadly lacking in past years.

The number of hydraulic plants installed on United States submarines depends on the mission or task for which the submarine was designed as well as the period in which it was designed.

The control surfaces, ballasting controls, propulsion plant valves and nearly all the important fighting equipment of a submarine is powered hydraulically. Snorkel mast, periscopes, communications antennas, capstans, winches, windlasses, missile handling and launching devices are operated from the hydraulic systems.

Practical application of hydraulics on a submarine is dependent upon the principle of Pascal's Law, which states that "pressure on any part of a confined liquid is transmitted undiminished in all directions throughout the liquid."

The hydraulic system on conventional attack submarines operates at a pressure of 600 psi with a sprinkling of 1200 psi systems in the group, while nuclear-powered fleet attack submarines have a 3,000 psi hydraulic system. Hydraulic system on the radar picket submarine *Triton* and the POLARIS missile-firing submarines also operates at a pressure of 3,000 psi. However, atomic-powered hunter-killer submarine *Tullibee* has a hydraulic system which operates at a pressure of 1,500 psi.

Since higher pressure hydraulic systems would only create more design problems for the already complicated submarines, Navy will not go beyond the 3,000 psi hydraulic pressure system for some time.

Reliability a Must — Much has been written about submarine fighting potential, but unlike the damaged surface ship which may be able to limp into port, a seriously stricken submerged submarine is just about a dead duck. For this reason, machinery and equipment which goes into a submarine must be reliable to the nth degree. While the hydraulic system of the submarine is generally considered to be extremely reliable, reliability improvements can never be relaxed as there have been occasions where breakdowns have caused submarine crews many anxious moments.

Navy's "Want List" — Aside from the reliability factor, there are several things which rate high on Navy's want list for improving submarine hydraulic system.

Noise reduction is foremost problem to overcome; another is how to prevent sea water from gumming up the works.

Submarine service is popularly known as the silent service, and

NAVY SERVICE-WIDE PURCHASES OF HYDRAULIC FLUIDS IN FISCAL YEAR 1960

Type of Hydraulic Fluid	Gallons	Cost
Petroleum-base (aircraft and ordnance)	3,295,721	$3,403,688
Preservative	166,970	183,940
Non-petroleum base (aircraft)	10,815	253,637
Artillery, recoil, special	13,500	28,812
Auto-hydraulic	13,100	31,970
Type No. 2	87,340	113,644
Fire resistant	142,425	427,673
Total	3,729,871	$4,443,384

The above table shows the volume and cost of hydraulic fluids purchased by U.S. Navy during fiscal year 1960. Unfortunately there is no immediate breakdown indicating available hydraulic fluid requirements for the various types of ships. However, underwater engineers estimate that a new submarine requires some 1,500 gallons of fluid in the main hydraulic system. Annual replenishment requirements depend upon usage and losses. The figures were furnished by Navy's Bureau of Supplies and Accounts.

modern day nuclear powered submarines are heralded by the press — and Navy itself — as silent marauders of the deep.

It is true that introduction of nuclear power has made submarines more silent — and it is equally true that surface antisubmarine forces have difficulty in locating the undersea craft — but submarines are a long way from being silent.

Although they generally concede to having achieved a 60 per cent reduction in submarine noise generation, experts know that work toward improvement must continue. To realize opportunities for improvement, BuShips would like a greater share of R & D dollars for hydraulic system research. Navy engineers will try for an increase in funds in fiscal year 1962 budget.

What Navy is looking for in its submarine noise reduction program is a variable volume piston pump for the main hydraulic system. Variable pumps are used by surface ships, but present units are too noisy for use in submarines.

For the past two years, Denison Research Foundation, Powell, Ohio, under Navy contract, has carried out extensive research to determine noise characteristics of all variable piston pumps on the market. Aim of this program is to find ways and means of reducing the pumps' noise output so they can be installed in submarines. Specific noise level requirement for Navy submarines is classified.

Hydraulic screw pumps now used in submarines are good, consistent in delivery, but variable volume piston pumps have easier control, and are generally more efficient.

Denison Engineering and Vickers, Inc. supply major variable delivery pumps now under consideration for use in submarines. None of these pumps has yet satisfied Navy's noise level requirements.

Concentrated Research — Looking optimistically into the future, Navy underwater engineers believe they have the knowledge which, with necessary funds and a concentrated R&D push, could result in development of a variable delivery piston pump for installation in submarines to be built under the Navy's shipbuilding program for fiscal year 1962.

Construction contracts for the 1962 shipbuilding program would be issued about December 1961, with actual building starting about June 1962. Engineering plants would not be installed in most new submarines until early 1963.

With such a time table, it becomes necessary for both Navy and industry to move quickly to step up hydraulic research and development programs. Navy is anxious that improved hydraulic pumps be installed in its new atomic submarines. The passing of each contract-awarding time means another year or more is lost before submarines can get the desired quiet hydraulic pumps.

Corrosion Is Handicap—Salt water contamination is a problem in the external antenna mast hydraulic system on many submarines, as actuators must be placed outside the pressure hull. Cause of the problem is seal wear and leakage.

Not only does corrosion reduce operating efficiency on the submarine, but the job of flushing and cleaning out the system runs into prohibitive figures.

Cost of cleaning out the contaminated hydraulic system of a submarine averages between $85,000 to $100,000. A recent hydraulic cleaning job on nuclear-powered REGULUS missile-firing *Halibut* cost Navy $150,000.

Alleviation of the contamination problem requires extra maintenance attention and better seals or new designs of actuators without seals.

Navy is continuously fighting the cancer-like corrosive attack on submarine hydraulic systems. A late move, which will soon be announced to all submarine skippers will require them to put rust-preventive sodium chromate into the hydraulic system whenever sea water is discovered in the system. Underwater engineers hope that sodium chromate will prolong the time before corrosion process starts. This additional time will increase chances for discovery and permit correction of the situation before damage occurs.

Standardization—"If"—Standardization, an often-heard word in military circles, is not looked upon with enthusiasm among Navy underwater engineers. While Navy tries to maintain the same types of hydraulic gears whenever possible, applying stiff standardization rules to submarine hydraulic systems is not considered practical. Engineers feel that standardization would slow down progress of developing and improving new systems. Furthermore, varied requirements of submarines, speed, tonnage, and hydrodynamics all influence hydraulic systems.

However, submarine experts are willing to accept standardization if a cheaper system can do the required job. As a matter of fact, standardization is being accepted in hydraulic systems whenever possible, but the submariners will not accept standardization if the newer system does not meet all reliability factors.★

Navy to Revert to Mineral-Base Hydraulic Fluid

As UE goes to press, we learn that BuShips has decided to give up phosphate ester hydraulic fluids for all subs and to go back to mineral-base fluids. The reason for this switch is the effect of leaking PE on conduits, power cable insulation, paint, etc. Navy experienced the same type of trouble when mineral fluids were first used, but overcame the prob lem through exclusive R & D work.

Similar R & D work will be carried out to combat the mentioned softening and destroying effects of PE.

PE costs approximately twice as much as mineral-base hydraulic fluids.

system reliability: importance increases with complexity

By E. J. Behney
Chief Design Engineer and Asst. Design Mgr.
Electric Boat Div.
General Dynamics Corp.

Reliability is the key word when it comes to hydraulics in submarines. Simply, it is a confidence factor in the performance of an item or the system. In the terms of the reliability engineer, it is the probability that a piece of equipment will successfully complete a specified mission under specified conditions of operation and environment.

Unlike many other defense programs, there are no separate contracts for reliability achievements in the submarines building program, but the design and building contracts incorporate definite directions to accomplish reliability goals. The submarine building specification lists maximum reliability first under the principles of design and construction.

Reliability is enhanced by a further requirement, in many areas of the specification, that there must be an alternate mode of operation immediately available, to circumvent a single casualty.

The detailed design prepared in accordance with these specifications determines the upper limit of reliability. The building trades, the inspector, the quality control engineer, the installing trade, and later, the repair and maintenance personnel, by doing a perfect job can only bring the product, in this instance, the hydraulic system to the level of reliability inherent in the design. All effort, less than perfect, following the design, degrades the reliability of the system to some point below the level established by the design.

Like the design of missiles and aircraft, the submarine design has moved into an area of vastly increased complexity because of the changing, expanding, and more important missions of the submarine.

The hydraulic system which has become really the heart, the arteries, and much of the muscle of the submarine, has, of course, kept pace with the complexity of the submarine as a whole. If we maintain only our present level of reliability in the design, manufacturing, quality control, maintenance, servicing, and all other functions that contribute to the sum total of reliability, we will have a descending total system reliability factor. Because of the fact that when a system complex made up of one item only with a reliability factor of something less than one, say for example 7/10, is incorporated in a more complex system that incorporates two units of the same reliability factor expressed above, the reliability factor drops from the 7/10 mentioned above to 7/10 x 7/10 or a resultant reliability of less than 50 per cent. This reasoning applied to the growth pattern on the subject systems makes it quite obvious that the role of the reliability contributor becomes increasingly important, to the point that the results of his efforts are a definitely controlling factor in the growth, and, therefore, the usefulness of these systems.

The submarine building yards, both governmental and private, receive contract plans and detailed building specifications for the submarines as part of the contractual conditions from the Bureau of Ships. The lead design yard must prepare detailed working plans in accordance with the specifications and contract plans. The lead design yards and building yards have a responsibility to advise the Bureau of Ships in light of their individual experience regarding inadequacies of all phases of the specifications and contract plans.

With respect to the hydraulic system alone for a modern submarine, the Bureau of Ships usually provides the contractor with three guidance diagrams, one for the main hydraulic plant, and one each for the steering and diving systems. From these contract plans and the relative sections of the shipbuilding specification, the contractor prepares about 15 detailed working diagrams and approximately 175 detailed plans of components and pipe details.

For today's submarines, the design contractor will expend upwards of 70,000 engineering and design hours in the preparation of this information and the engineering checkout of the system after it is completed.

This effort will bring into being a system that will have included in it about 30,000 ft of piping ranging in size from ¼ in. to 2½ in. I. P. S. in copper nickel, stainless steel, and copper, connected with approximately 20,000 fittings. Incorporated also will be about 2,000 valves of which about 300 will be low leakage precise control valves. Other items in the system include accumulators, pumps, desurgers, flexible fittings, strainers, variable restrictors, pressure gauges, thermometers, line vents, and flow regulators in impressive quantities.

This extremely complex system is installed in an extremely limited envelope that makes for difficult assembly problems that must be monitored by inspection and quality control experts. It must be arranged so that servicing and maintenance can be accomplished to provide long time trouble-free operation.

When the submarine is completed and delivered to the U.S. Navy, the contractor sends along a guarantee engineer for the period of the ship's guarantee, usually six months. This engineer is the means of feed-back to the contractor on performance of the ship and for most useful information for repair and improvements in general. Of course, there are other information feed-back channels such as the ship's force via arrival conferences prior to repair availabilities and the submarine commander's reports to the Bureau of Ships and the Supervisor of Shipbuilding office. These observation feed-backs are used on a long-range basis for the preparation of improved building specifications and on a short-range basis for individual corrections and improvement of the ship.

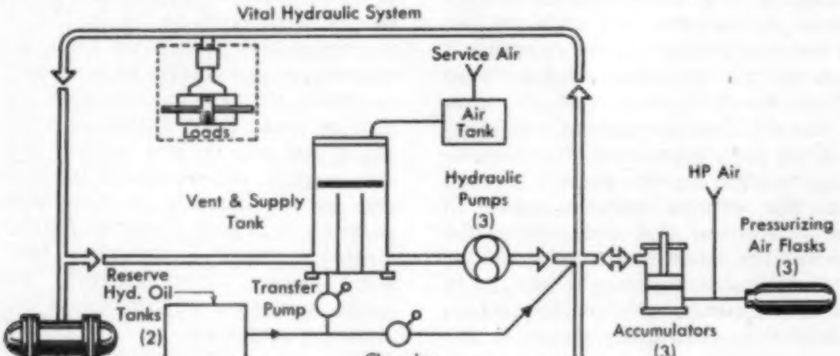
Submarine hydraulic requirements

have multiplied to the point where the 3,000 psi operating pressure level has become most desirable. The basic hydraulic generating plant is really a group of three units, almost identical in design and operation.

The principal parts of the unit are: 1) the main supply tank, 2) the pump, 3) the desurger which assures a smooth quiet flow, 4) the accumulator which receives oil from the pump and stores it at the required pressure for instant use, 5) the accumulator air flask which supplies compressed air to the accumulator, 6) the air load tank which applies moderate pressure to the oil supply, and 7) the supply tank, 8) the by-pass and relief valve, and 9) the pilot valve which controls the action of the accumulator and the pump.

The main supply tank has three bays, each supplying oil to its own generating unit. Compressed air from the air load tank exerts a pressure of from 10 to 60 psi to insure a positive suction to the pump. The compressed air and a wooden, rubber-covered float prevent foaming of the oil returning to the tank. The tank supplies oil to the pump of each power generating unit. The pump is positive displacement with three closely meshing rollers resembling worm gears, the middle one being driven by an electric motor. The other two are idlers. The meshing rollers are enclosed in a sleeve forming a continuous seal for the oil. The oil enters the pump at the suction port at a pressure of 10 to 60 psi and is driven by the action of the rotors through to the discharge port, reaching the desired pressure of 3,000 psi determined by the relief by-pass valve setting. The pump end rotor thrust is compensated by pressure balancing. The pressure pulses emitted by the pump are mitigated for sound reasons by the desurger on the pump discharge side. The desurger is made up of a housing which supports a perforated sleeve, around which is a rubber diaphragm which in turn is surrounded by an inert gas pressurized chamber. The diaphragm deflection acts as an absorber for the pressure pulses and a smoother, quieter oil flow results. The accumulator which accepts this oil flow is the energy storer for the system and augments the pump capacity under maximum system requirements.

The accumulator is a cylinder with a piston and tail rod. The pressure oil fills the tail rod side of the cylinder and compressed air from the accumulator air flask fills the part below the piston. The piston moves up and down as the oil supply and demand varies. Oil presses on the upper surfaces of the piston forcing it down while the compressed air exerts force against the lower surface of the piston tending to force it up. The air pressure force exactly balances that of the oil when the piston is at rest. The diameter of the piston rod determines the air to oil pressure ratio. The rod in the center of the piston slightly reduces the area subjected to oil pressure. Therefore, to maintain an oil pressure of 3,000 psi, a lesser air pressure, 2,825 psi is required.



Submarine central hydraulic power plant (simplified).

Leakage of oil or air past the lands of the piston is prevented by two seals which have a vent to atmosphere through the tail rod between them. The purpose of this vent is to minimize the possibility of air and oil mixing so as to reduce explosive hazards.

When the accumulator is fully charged, the oil supply from the pump must be cut off, and when the oil is almost exhausted, the supply must be resumed. The action of the accumulator is controlled by the interaction of several valves and devices; a bicycle type chain, a series of cams and levers, a pilot valve, a by-pass and relief valve, and a check valve. Pressure oil from the pump holds the check valve open and allows flow of the oil until the accumulator is fully charged. As the piston moves down to its lower limit, the tail rod chain actuates the cams and levers which position the pilot valve. The pilot valve in turn, opens the by-pass valve, by-passes the oil back to the main supply tank, while the check valve traps the pressure oil in the accumulator. As the accumulator is depleted, the tail rod moves the chain to the upper position, the cams and levers actuate the pilot valve which in turn allows the by-pass valve to shut. Then the pressure oil from the pump forces the check valve open and recharges the accumulator.

In what is termed as the standby mode of operation, a contact maker operated by a cam shuts off the pump motor when the accumulator is fully charged. And, as the oil in the accumulator approaches exhaustion, the contact maker is actuated to again start the pump motor.

The three separate units of the basic hydraulic generating plant are called lead, main, and vital. The lead accumulator discharges into the main hydraulic header and into the vital hydraulic header. The lead accumulator piston rod has a larger diameter than the other piston rods and, therefore, less area. Thus, the oil exerts less force on the piston. Because of this, the lead accumulator always discharges first and replenishes last. Upon depletion of the lead accumulator, the main accumulator discharges into the main header for the operation of the units of the main system only. Upon depletion of the lead accumulator, the vital accumulator discharges into the vital header for operation of the units in the vital system only. In case of failure, of either the main or vital accumulator, a cross connection is provided to keep the whole system in operation. Thus, the lead pump and accumulator will operate alone when there is small demand upon the system. The main and vital accumulators operate in conjunction with the lead accumulator when the demand is increased lending greater reliability and flexibility to the system in case of casualty. The main system supplies hydraulic power for the operation of fairwater planes, stern planes and rudder. The vital system supplies power for the operation of hull openings and other functions on which the submarine depends for survival.★

the design engineer's job: to provide built-in reliability

By W. H. Tisdale, Jr.
Senior Design Engineer,
Electric Boat Div.,
General Dynamics Corp.

The engineer responsible for design of submarine hydraulic systems has many tools at his disposal to aid in attaining the ultimate goal of maximum reliability. In addition to feedback of information from operating vessels and other sources, the engineer must develop a few tools of his own.

One of these is hydraulic density ratio — an indication of the complexity of hydraulic systems designed into a particular submarine in any one year, relative to a base year. Density ratio for the 1950-1960 decade is shown in Fig. 1.

Density ratio is found by computing the product of installed hydaulic systems horsepower and number of installed components for any year, and relating it to the base year. Density ratios in excess of one indicate increased complexity; conversely, density ratios less than one indicate decreased complexity. Density ratio is, then, an index which shows us where we are and where we may be going, relative to where we have been.

Density ratio important — For the past ten years, Fig. 2 shows pressure ratio; Fig. 3 shows horsepower ratio; and Fig. 4 shows component ratio.

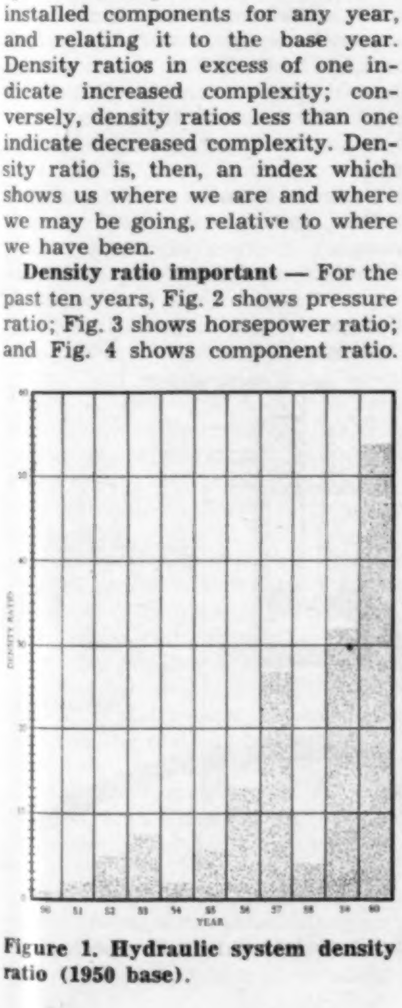


Figure 1. Hydraulic system density ratio (1950 base).

Density ratio is the important tool since it combines factors of pressure, horsepower, and component ratios. With the increase in these ratios, the designer has had no time to relax as far as reliability is concerned.

How does one keep pace with the increasing need for reliability? There are two approaches available to the designer: One, continue to advance the state of the art of component design and manufacture; the other to design the maximum degree of reliability into the system.

Many things are done along these lines to promote confidence, safety, and endurance in submarine hydraulic systems.

These systems require cooling: sea water is the most abundant coolant. However, the corrosive effect of even a small amount of sea water in the internal hydraulic system cannot be tolerated. To prevent sea water contamination, a double tube heat exchanger with leakage warning is used (Fig. 5).

Leakage warning — The tube bundle consists of tubes within tubes with a small annulus in between. This annulus is drained to a single leakoff tube. The leakoff warns of any leakage into the annulus whether from hydraulic fluid or sea water side of the cooler. The valve is provided so that the cooler may

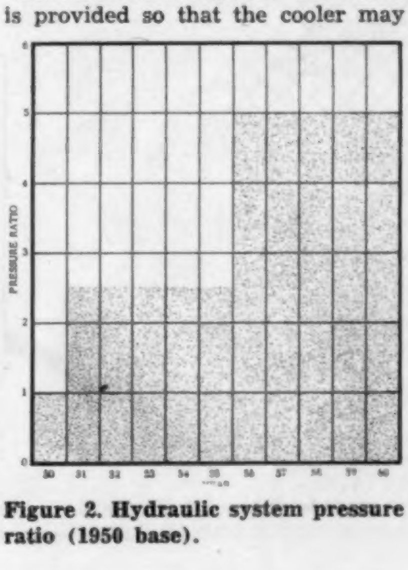


Figure 2. Hydraulic system pressure ratio (1950 base).

be maintained in use at the discretion of the operating personnel after a leak has been detected. This is accomplished by simply closing the valve to prevent leakage into habitable spaces of the ship.

Sea water can also enter the system in actuators located external to the pressure hull, that is, in sea water subject to submergence pressure of the surrounding ocean. Here, a system for these components separate from the ship's internal hydraulic system is provided. In addition, each actuator is fitted with a double seal with a "tween the seals leakoff" as shown in Fig. 6. The leakoff line is provided with a normally open valve.

System accumulator — Another component is the hydraulic system accumulator. Again the double seal principle is used with several other features. A typical hydraulic system accumulator is shown in Fig. 7.

The double seal is used to prevent transmission of gas to the hydraulic fluid and vice versa. Since the commonly used gas is air, the importance of preventing an interconnection of gas and fluid is obvious.

The normally open valve is again utilized on a tell-tale leakoff. These accumulators are designed to withstand five times the working pressure of the system. In addition, the ASME unfired pressure vessel code is used for design guidelines. In order to comply with these require-

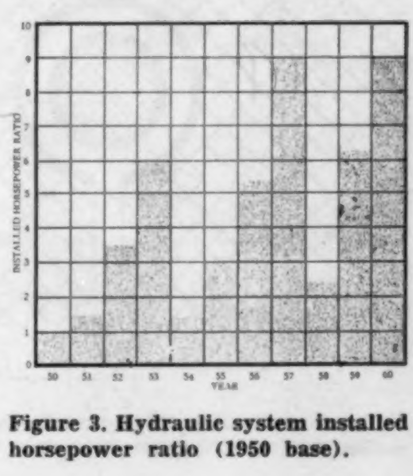


Figure 3. Hydraulic system installed horsepower ratio (1950 base).

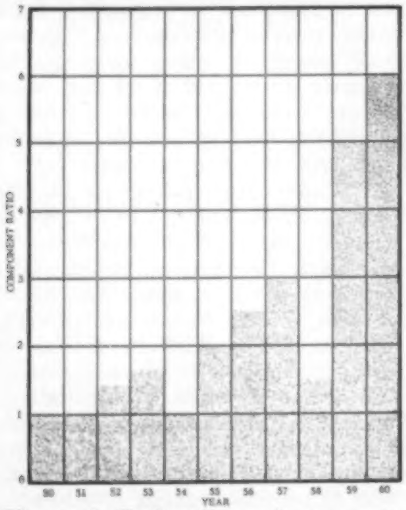


Figure 4. Hydraulic system component ratio (1950 base).

ments and to provide long life and corrosion resistance, a unique combination of materials is used in the cylinder barrel: the barrel is a dual metal stainless steel casting; the inner shell is type 316 for corrosion resistance; the outer shell is type 416 for strength; the bore is chrome plated to provide a hard corrosion resistant wearing surface. Quad rings are used throughout for dynamic sealing since their in-service life has exceeded that of "O" rings and other standard seal designs.

Increasing Reliability — The fact that a component failure can occur and that such a failure can cause loss of a vital system must be recognized. That such a casualty can jeopardize the safe return of ships and men is of the utmost significance. Therefore, it is obvious that something must be done to increase overall reliability in order to prevent the occurrence of such gross failures.

Comprehensive purchase specifications, continued monitoring of vendor designs, and detailed qualification and production testing provide part of the answer. Competent vendors with long experience in the marine, aircraft, and allied fields provide another part of the answer.

It is only natural then to approach the circuits — the configuration of piping and components which make up the system complex.

A high degree of reliability in primary and secondary submarine hydraulic system circuits is the objective, especially for those systems which directly support ship control. These are control surface systems for rudder, stern planes, and bow or fairwater planes.

A modern submarine control surface system is an electro-hydraulic servomechanism. Control is achieved through an airplane-like stick control or by means of an auto pilot. Position of the control surface is proportional to position of the stick (here the manual or stick control mode only will be examined), therefore, the system is, in the venacular, a type O servo — a position control system. There are two basic types in use in submarines today — the pressure demand and the constant pressure system. The basic difference is that in the pressure demand system, power source (usually a pump) produces only enough pressure to move the load and overcome friction; in the constant pressure system, source pressure (usually an accumulator) remains nearly constant and is reduced as necessary by restriction to level required to overcome load and friction. The constant pressure system will be examined, in an attempt to show how the highest degree of reliability can be provided throughout.

Two Operation Modes — A typical submarine control surface system in normal operation utilizes two modes of operation, the "normal" and "emergency" modes. In the normal mode, operator positions the stick and the surface moves to agree with the selected position. Power is derived from the main hydraulic system. (Fig. 8).

Fig. 9 shows the system in emergency mode. Power transfer valve has shifted to the emergency position, at which time the operator moves the stick to set the emergency control valve, and flow from the vital system is directed to and from the control surface ram. When cessation of motion is desired, stick is returned to neutral. This mode is sometimes called rate control, since the rate of surface rotation is proportional to stick position.

In Fig. 8 the system is in normal servo position mode with power coming from the main system. This is the mode which would always be in use unless a failure had occurred or the emergency mode had been selected. Emergency mode is then the back-up.

In high speed nuclear submarines, a rapid automatic shift to emergency mode on failure of the normal mode is mandatory, or loss of ship control is liable to result. The operator must have the utmost confidence that this shift will occur. If it does not, immediate recovery action must be taken.

Fail-safe features — Although not shown, elaborate electrical fail-safe features are provided. The servo valve is driven electrically by a force motor. Power for the force motor is derived from a magnetic amplifier. The magnetic amplifier power sup-

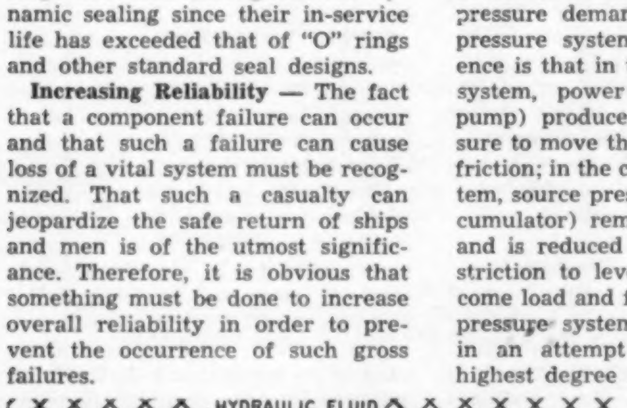


Figure 5. Schematic of hydraulic system double tube cooler.

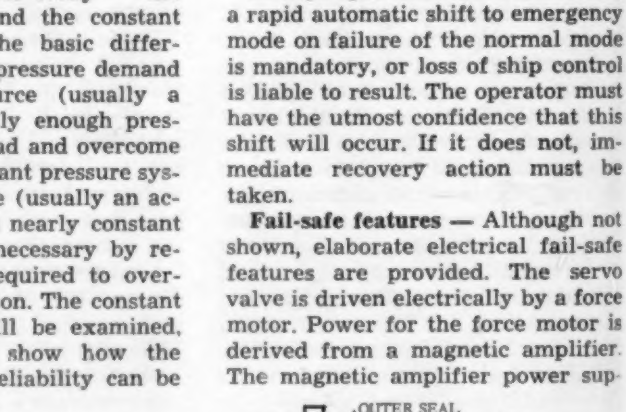


Figure 6. Schematic of typical externally located hydraulic component.

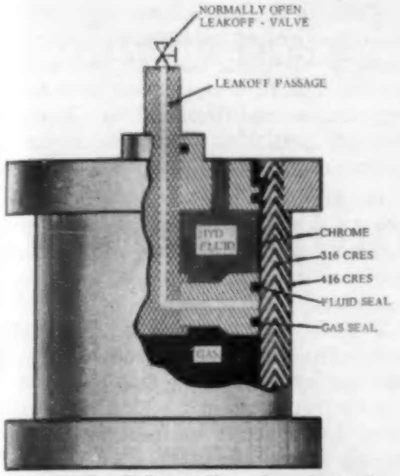


Figure 7. Schematic of submarine hydraulic system accumulator.

ply and the power transfer valve pilot valve solenoid are connected in series. Thus a power failure will cause the solenoid to de-energize. Vital hydraulic pressure on the large actuator of the power transfer valve causes a shift to emergency power. The emergency control valve, attached directly to the stick, directs vital system fluid to the ram. An automatic shift to emergency has occurred.

Magnetic amplifiers — In reality, there are two magnetic amplifiers. One motivates the servo valve, the other monitors a dummy load with essentially the same electrical characteristics as the servo valve. Any significant change in servo valve electrical characteristics is compared with the dummy load by an electrical differential device. If the change is significant, the solenoid is de-energized and an automatic shift to emergency occurs.

An electrical device which will measure time difference between order and response is being developed. If response does not occur within a pre-determined time after order, the solenoid will de-energize. This device will obviate many present fail-safe features if it proves successful.

The hydraulic actuators on either end of power transfer valve are essentially a differential pressure relay. When main hydraulic pressure falls to a pre-determined level, force exerted by the larger actuator on the vital system end is greater than that on the main system end due to difference in areas and valve shifts to the emergency mode. The vital system both causes a shift to and provides power for emergency control.

One assumption that has been made throughout is that either main or vital power is always available or the intent is not accomplished. This assumption is valid since the basic requirement for the hydraulic power plant is: "A single casualty shall not cause complete loss of hydraulic power."

When hydraulic density was relatively low, the practice was to install separate independent systems. Unfortunately, hydraulic density and space to install separate systems have not increased proportionately. Space has won out over separate systems, thus a new concept was born. This was the centralized submarine hydraulic power plant wherein a central power generating source was provided to produce power for both normal and emergency control modes. Referring to hydraulic density, it is evident that unless special precautions are taken, reliability is compromised. It is a fact that this was the case.

Reliability compromise? — When nuclear propulsion and the *Albacore* hull were wed, this compromise could not be tolerated. Consequently, either a new concept had to be applied to a centralized power plant, or the old concept of separate systems had to be revived. The compromise for separate power plants in limited space available was reduction in accessibility for normal maintenance and replacement of worn or defective components. The question was — how could we have our cake and eat it — how could we save space, install more hydraulic horsepower, and comply with the requirement that a single failure, no matter what, would not cause a complete loss of hydraulic power? Fig. 10 depicts a simplified version of what was felt to be the solution. This basic hydraulic power plant system has been installed on nuclear submarines in various ramifications since about 1956.

This system consists of what is considered to be three independent-interdependent units. When the system is operating normally, units are interdependent. In the event of a single failure, two units may cease to operate due to lack of hydraulic fluid; the third, however, will continue to function. Thus, the system is normally interdependent and, after a failure, automatically inde-

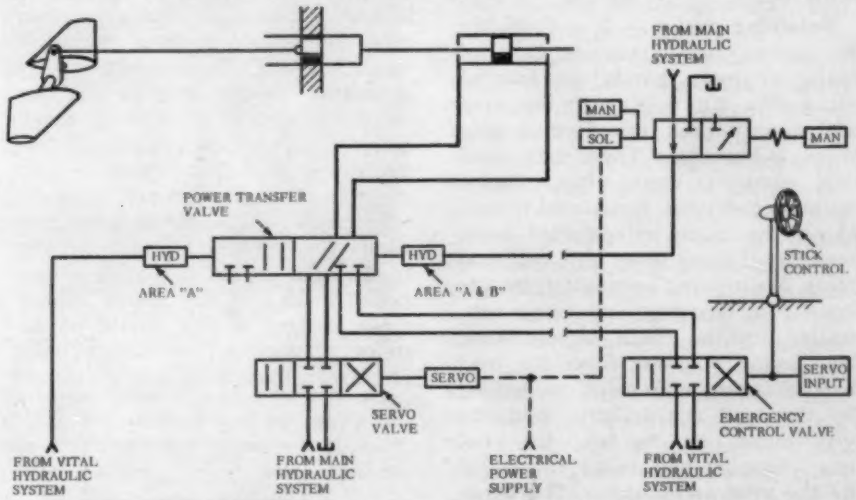


Figure 8. Typical submarine control surface in normal (servo) mode.

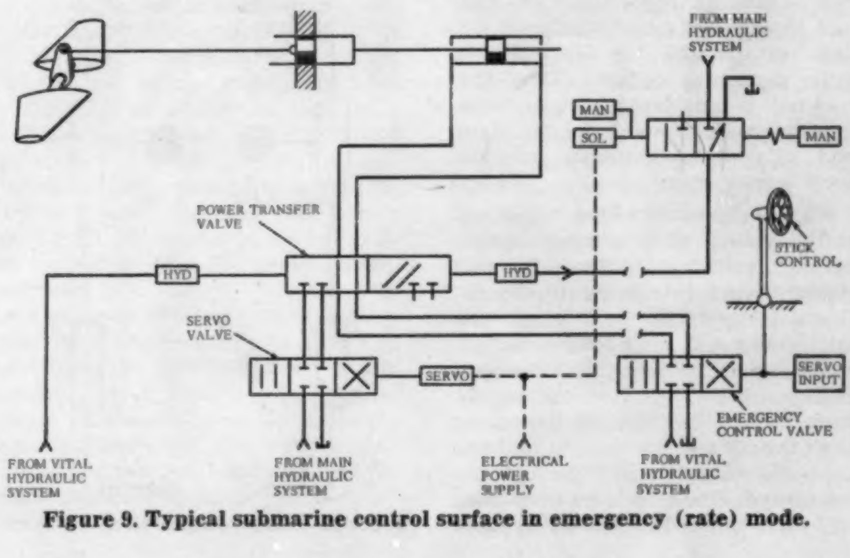


Figure 9. Typical submarine control surface in emergency (rate) mode.

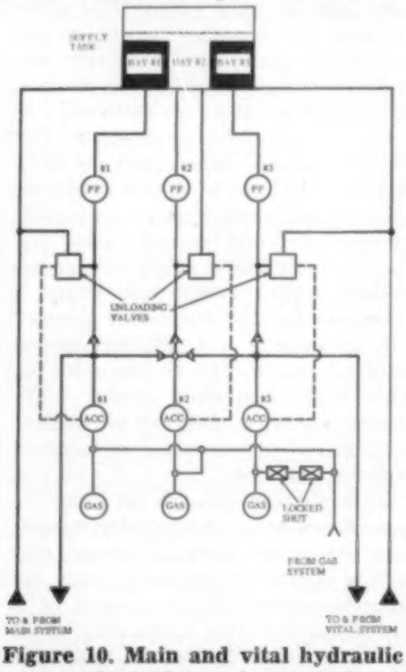


Figure 10. Main and vital hydraulic power plant shown in normal operation.

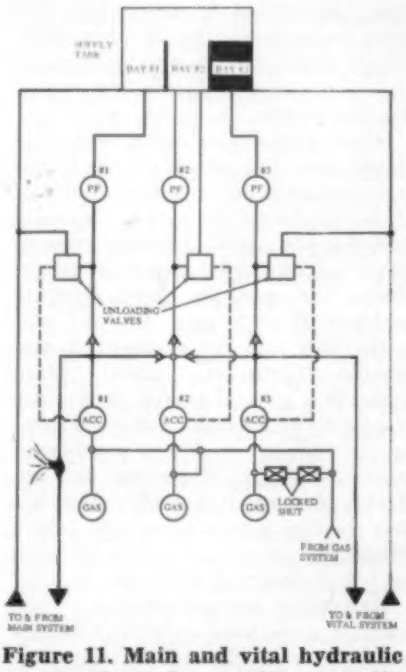


Figure 11. Main and vital hydraulic power plant shown after casualty in main system.

pendent. How is this reliability achieved?

Retaining power — It is desirable to retain vital power on loss of main, or main power on loss of vital. (Fig. 8). In Fig. 10 the vent and supply tank are divided into three independent lower bays and one common upper bay. Under normal conditions, fluid level is well above the three independent bays, serving all three units on a common basis. Main pump operates from the main bay, charging and being controlled by the main accumulator; lead pump operates from the lead bay, charging and being controlled by the lead accumulator; and the vital pump operates from the vital bay, charging and being controlled by the vital accumulator. The array of check valves shown in the common discharge header allows lead unit to augment either vital or main unit, as dictated by demands on those particular systems. Thus, the lead unit is considered to be common to either main or vital and the main and vital units common only to their own systems.

Fig. 11 shows what has happened to the system after a total rupture of the main supply line. A total rupture represents an essentially infinite demand. The lead pump has augmented the main pump in attempting to satisfy this demand. Common bay of the vent and supply tank, the #1 bay, the #2 bay along with the #2 and the #1 accumulator have discharged rapidly through the rupture, discharging large quantities of hydraulic fluid to habitable spaces of the vessel. The #3 unit continues to operate independently, supplying hydraulic power for the emergency mode of control surface operation. Assuming that control surfaces were in normal power prior to this casualty, an automatic shift to emergency occurred when main and lead pressures were lost. Thus, control surfaces continued to operate on the vital system at somewhat reduced capacity even after a total casualty in the main system. Had this happened in one of the newer submarines, danger of fire would be extremely low since fire-resistant phosphate ester base hydraulic fluids are used.

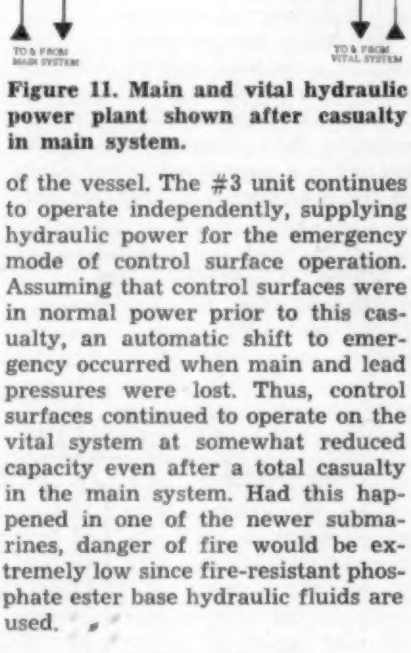


Fig. 12. Power distribution system.

Thus, it is shown how one single casualty, picked at random, did not cause a complete loss of hydraulic power, and how the power generating source was designed to support the all important control surface systems.

Distribution system — The electrical power distribution system which provides the prime motivation for the hydraulic pumps must be examined. Major source of electrical power on present-day nuclear submarines is the 60-cycle ac generating system. It so happens that the hydraulic pumps, main, lead, and vital, are electric motor driven, deriving power from this system. If the total concept of "a single failure shall not cause a complete loss of hydraulic power" is to be carried out, it is obvious that the electrical distribution system must be considered.

Fig. 12 is a generalized schematic of generators and distribution system. Number 1 and Number 2 T.G. sets are turbo-generators — steam-turbines driving the two generators. These derive their power from the nuclear power plant. The two turbo generators serve their respective T.G. and M.G. buses. The M.G. bus is connected to the T.G. bus through the bus tie switch. Normally the M.G. sets act as ac motor-driven dc generators to maintain batteries at full charge. At least one of these M.G. sets will be operating in this manner when the ship is under way to maintain batteries at full charge. In the event of failure of either T.G. set (for example, No. 1), a detector senses the failure reversing the function of the No. 1 M.G. set. Thus, the ac motor becomes an ac generator and the dc generator becomes a dc motor. No. 1 G.M. set (abbreviation is reversed to denote reversed function) attempts to supply ac power to No. 1 M.G. bus and No. 1 T.G. bus. It is not capable of doing this, so a detector in the bus tie switch opens the switch. The G.M. set carries on supplying power to the No. 1 M.G. bus and the No. 1 T.G. bus is without electrical power. No. 1 hydraulic pump was put out of commission due to a single electrical casualty, but all hydraulic power was not lost.

Other utilizations — Reliability from both a component and a system point of view is carried out in other systems; for example, missile launching hydraulic systems on fleet ballistic missile submarines. This concept can be utilized in many variations and ramifications on submarines and perhaps in other applications.★

the user's point of view:

navy requires the utmost in reliability

By Capt. D. Kern, USN
Material Officer
COMSUBLANT

Efforts by industry and our naval shipyards to make submarine hydraulic systems more reliable are not wholly motivated by a philanthropic desire to serve the Navy. The reputation of the submarine design and shipbuilding activity can rest to a very great extent on the performance of the hydraulic system.

Once a submarine is at sea, experience has taught us that nothing, except perhaps loss of main propulsion power, can be more disturbing to the submarine operator than loss of hydraulic power or repetitive hydraulic system failures continually jeopardizing the advertised performance of the system, or worse, the mission of the submarine.

Many of the reasons that submariners hold performance and reliability of their hydraulic systems to be a matter of vital concern may not be readily apparent to those having only casual or infrequent contact with submarines. An examination of Navy's guidelines and specification requirements does not help materially to reveal the basis for this concern. Therefore, one has to search out those functions and evolutions which are dependent upon the hydraulic system for control or actuation and which the operator expects will be performed with unfailing reliability. These include:

- **Depth control,** which must head the list, though present day literature and artists' conceptions of a submarine's submerged operations would leave one with the impression that penetration of vast ocean depths is routine and only limited by the fact that the ocean does have a bottom. We look forward to that day, but in point of fact, the submarine today has an extremely thin slice of the ocean's immense depth available for maneuvering in the vertical direction for reasons of attack and evasion, radical high speed maneuvers within this thin

Capt. D. Kern

slice are essential to the modern attack submarine's mission, and this dictates the utmost in reliability for control and actuation of the stern diving planes and sail planes — the control surfaces that adjust the submarine's depth. Loss of plane control at high speed in a steep angle leaves precious few seconds for corrective action to avoid either an inadvertant surfacing where the enemy awaits, possible collision with a surface ship, or a penetration beyond test depth and down to where the pressure hull will collapse. Both situations are to be avoided, and, the only answer is maximum reliability in the hydraulic system serving the depth control surfaces.

- **Course or steering control,** a function well understood, obviates that reliability in the hydraulic system controlling it. This is as important to the submarine as reliability in the steering system of any surface ship or vehicle that has freedom of movement in the horizontal plane.

- **Under ice operations,** now a routine evolution for nuclear submarines, imposes additional performance and reliability requirements on the submarine's hydraulic system. Here reliability of both depth and steering control are crucial to survival under Arctic ice, where little or no possibility of surfacing exists. The choice of down angle or up angle on jammed stern diving planes at high speed, with a thick canopy of ice overhead, and the crushing pressures of the depths below, would be a difficult one to make. Therefore, precision control in three dimensions is required to navigate these shallow ice-choked areas. *Nautilus, Sargo, and Seadragon* all found radical maneuvers essential in their transit of the Bering Strait in order to avoid collision with deep penetrating ice formations, and to thread a course with sufficient water between the underside of the ice and the bottom. Arctic operations have also demonstrated the need for a most exact degree of ballast control in making vertical ascents at zero speed of advance to surface in open water polyna or in an area of thin ice. Here reliable operation of main ballast tank vent valves and negative tank flood and vent valves is critical.

- **Endurance** is a measure of the submarine's ability to transit and remain on station for long periods of time, and is a characteristic directly dependent upon reliability of the hydraulic system. In this age of high performance electronic search devices, it is essential the submarine remain submerged during the entire patrol period, performing without benefit of logistic support of any kind. Therefore, the amount of hydraulic oil carried on board, and the rate of usage of this oil must be compatible with the duration of the patrol. This dictates a high degree of reliability in hydraulic system seals and joints to insure a low leakage rate. Similarly,

a submarine's rate of usage of hydraulic system spare parts must be minimized since all replacement parts must come from an on-board supply and the volume of spares that can be carried is small since stowage space in a submarine is a critical commodity.

• **Operation of masts** is in many instances critical to the mission of the submarine. The masts are raised using hydraulically powered lifting cylinders, and when raised, provide the eyes, (periscope and radar), the ears, (communications antenna), and the breathing facility, (snorkel), for the submarine. Reliable operation of the masts is necessary for the submarine to carry out its mission with the degree of concealment that is essential for survival.

The critical question is what is the in-service reliability record of our modern-day submarine hydraulic systems? It can be fairly said that the operating forces have every confidence in the reliability of the hydraulic systems being fitted in the submarines they are taking to sea; and since World War II, we have not lost a submarine as a result of a casualty in this system. However, when we examine the record in detail, numerous hydraulic system casualties come to light, evidencing aspects requiring attention to improve reliability. Further, this need for increased reliability immediately becomes more urgent when it is considered the wartime climate this system must perform under includes hazards such as high shock not experienced during peacetime operations of the systems. With the aim of stimulating renewed effort and ingenious innovations to bring the systems closer to that apogee, the following typical examples of hydraulic casualties are cited with comments as to cause and effect:

System design errors or deficiencies have generated some interesting casualties. Two prime examples being:

1) Complete loss of steering as a result of the rudder taking charge when the submarine was backing down; thereby overhauling the hydraulic steering ram and slamming the rudder into the mechanical hull stops. The basic cause was failure of the design to recognize that torques in excess of the steering system's maximum resisting capability could be generated with the ship going astern at a moderate speed with the rudder amidships. On one occasion, this lead to completely demolishing the steering system's mechanical appurtenances, including the mechanical hull stop, the rudder angle indicators, mechanical follow-up linkages, drift stop rams, etc. Fortunately, a lube oil pump foundation prevented the complete stampede of the hydraulic ram out of its cylinder. On another occasion, the hydraulic system attempted to restrain the rudder's rapid transit to the stops but the relief valves could not handle the volume of oil flow and the system was over-pressured resulting in bulged pipe, damaged relief valves and stretched cylinder head bolts.

2) Over design of mast hoisting cylinders and hydraulic actuating cylinders led to excessive mast hoisting speeds and excessive speed of valve actuation. In the early designs of 3000 psi systems, this problem was prevalent and the excessive operating speeds resulted in damage to components. The corrective action taken, installation of orifices to slow the rate of flow, in some instances merely substituted another problem, over-heating of the oil.

Component malfunctions are often simple and readily correctable, and, if considered as an isolated incident confined to the component, are of little consequence. However, experience has demonstrated the simplest component malfunction can on some occasions have an impact on the system both serious and difficult to recover from. Examples of this type of casualty are:

1) During a radical change in depth, a submarine experienced failure in the normal hydraulic system power to the stern planes. The planesman controlling the submarine immediately took action to shift to the emergency mode of operation. The power transfer valve that the planesman energizes to perform the shift from the normal to emergency mode failed to shift and the stern planes remained where he had last positioned them—on rise, fortunately. The submarine immediately broached the surface — luckily no surface ships were directly above. The cause of this casualty was subsequently determined to be a jammed spring in the spring loaded pilot valve that failed to position the pilot as ordered by the planesman. (Fig. 1)

2) Under similar maneuvering conditions on another submarine, the gear train in the stern plane follow-up system differential jammed, causing a constant error signal in the servo loop which drove the stern planes to hard dive. The casualty in the follow-up gear and linkage also affected the stern plane indicator system, causing the indicator at the diving control panel to show the planes going toward rise. This set of circumstances was most confusing to personnel attempting to control the ship. The submarine continued into a steeper dive until last ditch recovery measures were initiated (i.e. blow all main ballast all back full!) and the submarine surfaced. A fatal casualty was averted due to quick action on the part of ship's force and pure luck in that they had a clear area above them in which to surface. The cause of this casualty was simple binding of the gears in the follow-up differential but the results were near catastrophic.

3) During the sea trials of a POLARIS missile submarine, the bypass relief valve which directs the flow of oil from the main IMO pump either to the system supply or back

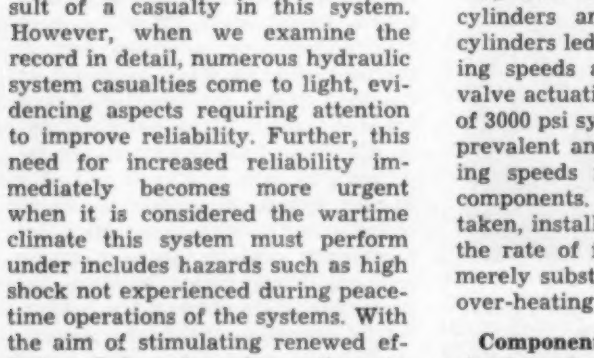


Figure 1. Power transfer valve that failed to shift.

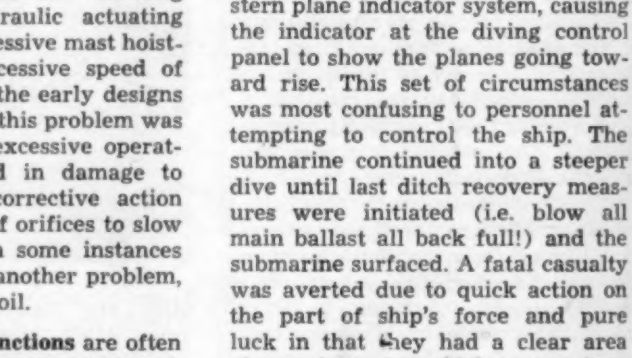


Figure 2. Pump bypass and pilot relief valve.

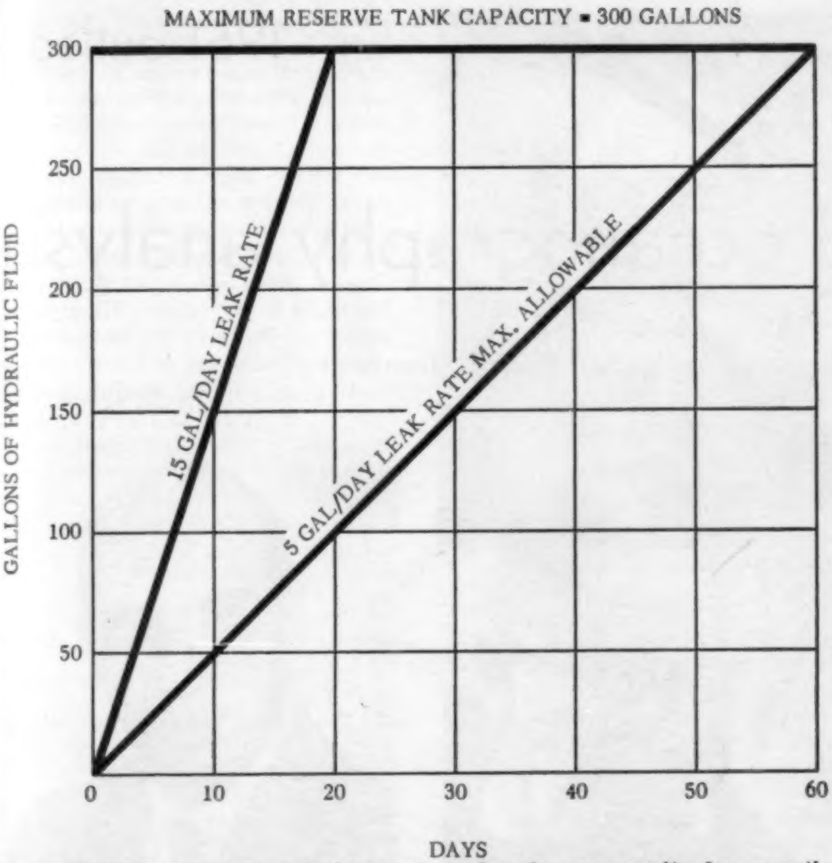


Figure 3. Hydraulic system leakage rate and make-up capacity for a particular vessel.

to the vent and replenishing tank when the accumulator is charged, failed to by-pass and relieve the pressure. The supply side of the system was immediately over pressurized and a 2½" diameter pipe blew out of its silbrazed joint at an elbow immediately adjacent to the IMO pump. The entire hydraulic oil supply for the main pump was dumped into the sternroom of the submarine, and unfortunately, the ruptured elbow directed the flow toward the overhead which completely saturated the entire area with oil. Fortunately, no fire resulted. Upon disassembly of the bypass relief valve, it was found that the shuttle valve had a mid-position in which no flow could occur, i.e., no interflow was allowed. The shuttle valve was stuck in this position. No flow to the hydraulic operator on the unloading valve could occur; the pump could not bypass, and the accumulator was full. Therefore, there was nothing the pump could do but build up pressure until a failure at the weakest point occurred (Fig 2).

Leakage and failure of hydraulic line fittings and components have plagued some of our recently completed submarines. The problem of leaky fittings stems primarily from an effort to obtain fittings that are light, compact, and readily assembled and dissembled with of course no sacrifice in reliability, system tightness, etc. The gains desired have been achieved in one class of submarines but unfortunately only at the expense of system tightness. Leakage rates as high as 15 gallons per day have been encountered. At this rate a planned 60 day patrol would have to be aborted on the 20th day due to complete depletion of the oil supply carried on-board (Fig. 3).

The cause of such a fitting leakage problem can be partially attributed to two factors; first, lack of specialized training in installation techniques and other workmanship problems, and secondly, details of the fitting design based on a level of installation detail, alignment, and space to work in that is not compatible with the conditions found in submarine construction.

A particularly serious type of casualty occurring on three occasions during the past year involved the rupture of hydraulic valve bodies. In all three instances, the character of the rupture had been such that the fluid leakage had been in the form of a fine aerosol mist. Experience with explosions and fires in the aircraft carriers *Leyte* and *Bennington* and in aircraft hydraulic fluid fires has demonstrated the seriousness of the explosion and fire hazard that exists in the presence of aerosols of hydraulic fluids. Again, most fortunately, the circumstances have been such that all of the factors necessary to initiate the explosion were not present and the casualty was reduced to simply loss of oil and a valve failure requiring replacement of the valve.

The cause of rupture in these valve bodies has been attributed to lack of sufficient allowance for repeated system peak pressure surges when selecting the valves. This led to installation of valves with little or no margin of reserve strength in relation to the stresses generated in the body due to the maximum pressure peaks in the system.

Contamination — Salt water contamination of the submarine's hydraulic system, due to leaks in fittings and packings that are exposed to salt water at deep submergence pressures, has occurred repeatedly in all types of submarines. This type of casualty does not have the same degree of impact or urgency as the previously mentioned casualties; however, it will eventually jeopardize the safety and military readiness of the submarine if the contamination is not discovered and corrected within a reasonable period. The slow, cancer-like corrosive attack of all fittings and components that occurs when salt water is allowed to remain in the system has proved to be extremely costly in terms of repairs required and lost submarine operating time. The cause of salt water contamination is due primarily to failure of silbrazed pipe joints, mechanical joints, and failure of O-ring seals in sliding joints required for mast hoisting rods and similar applications. Even with the special double O-ring seals that have been developed for submarine service, salt water contamination continues to be a problem.

Built in hydraulic system safety features, alert and aggressive action on the part of the submarine crew, and a little admixture of luck have in all cases prevented the casualties noted above, and many similar casualties, from ending in a "sub missing — sub sunk" situation. However, the proximity that some submarines have found themselves to this point of no return, while recovering from a hydraulic system casualty, certainly makes it crystal clear that we cannot be complacent in our attitude toward hydraulic system reliability and that our efforts toward improved reliability must penetrate to the smallest details of the elements that compose the system.★

1960 review  1961 outlook

asw, usw and oceanography analysis

By UE Magazine Advisory Board Members

'60 Systems Development Improved ASW Prowess

By Alton D. Anderson
Director, Cook Research Laboratories
Div. Cook Technological Center

Sparked by the organization of BuWeps for management and direction of weapon system programs, new weapon system developments advanced fleet ASW effectiveness in 1960. Considering the minimal expenditures in ASW weapon system research and development, the progress made in 1960 is remarkable. Prime examples of that progress include:

1) ASROC — This long-range surface ship system was delivered for OpTevFor evaluation, evaluated, and accepted for fleet use.

2) ASTOR — This weapon provides a fleet capability against high speed deep diving targets. This new weapon has gone to OpTevFor for evaluation.

3) Mk 112 Fire Control system — The system was delivered for and is undergoing fleet evaluation.

4) PUFFS — The system was delivered for and is undergoing experimental evaluation.

5) AN/ASN-30 — The fire control computer was delivered for and is undergoing fleet evaluation in the framework of its weapon system.

6) SESCO — The system was delivered for and is undergoing experimental evaluation.

From these examples, calendar 1960 progress in detection, classification, communication, acquisition, fire control, weapons, launches, and launch control is readily observable. Calendar 1961 will show even more progress in weapon system technology. In 1961 we can expect to see:

1) SUBROC — Since this system development is meeting its accelerated schedule, evaluation experiments of the Mk 113 Fire Control system can be expected to begin in 1961.

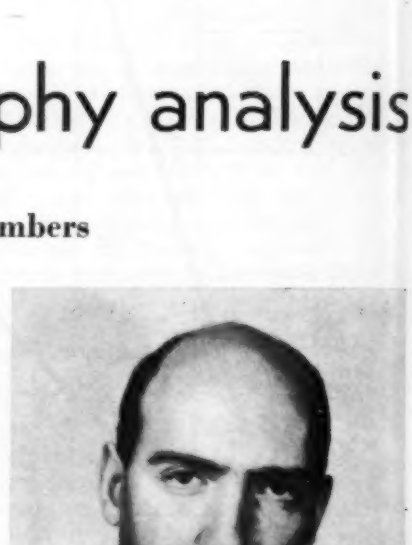
2) DASH — The rapid progress made under the integrated BuWeps organization indicates that fleet evaluation of the DASH system in 1961 is likely.

3) EX-10 — Research progress in weapons indicates that procurement of this new weapon system will be initiated in calendar 1961.

4) 350-ton PCH — Research progress indicates that procurement of this new weapon system will be initiated in calendar 1961.

Additionally, U.S. Navy recognition that the paucity of applied research in ASW system technology has contributed to developmental delay, will foster initiation of the much needed effort in this area.

Alton D. Anderson



Dr. Paul Kaplan

* * *

Hydrodynamic Research Was Fruitful In 1960

By Dr. Paul Kaplan
Chief Hydrodynamicist
Technical Research Group, TRG, Inc.

In 1960 the contract for the PCH was awarded, which will lead to the construction of a 100 ton hydrofoil patrol craft. At present a relatively large hydrofoil research program has been formulated and is being implemented by BuShips and ONR. Plans are now being formulated for a 300 ton hydrofoil boat. This is an experimental craft with subcavitating foils and the plans are to convert it to supercavitating operation in the future. It appears that the aim is to get large, high-speed hydrofoil craft for naval operational use.

A great deal of work has also been carried out on vehicles of the "ground effect machine" (GEM) variety. There has been a large program carried out at the David Taylor Model Basin as well as a great deal of interest by private companies. Experimental vehicles based on this concept have been built by the Hughes Tool Company and by Bell Aircraft, and these vehicles have been bought by the Navy. The plan is for further support of research for future developments which are primarily aimed at operation over water. The basic question is the feasibility of larger vehicles, with research aimed to answer this question.

The most obvious success during 1960 has been the fact that the POLARIS missile system is now operational, and it is known that long range missiles of this general type are being developed.

Special boundary layer studies have been started for the study of the effect of special elastic coatings and other techniques such as gas films for drag reduction of underwater bodies. Additional studies are planned for this subject in the future and promise the possibility of high speed underwater bodies.

As a result of studies related to the POLARIS development, a program to determine the directional properties of irregular ocean waves will be started in the near future.

Developments are being pushed for applications of LASERS for detection purposes. The LASER is a high intensity coherent light source which has been successfully demonstrated by a few companies.

★ ★ ★

Dr. Winston E. Kock

Dr. Waldo K. Lyon

Sound Propagation Study Poses A 1961 Challenge

By Dr. Winston E. Kock
Director and General Manager
Research Laboratories Div.,
The Bendix Corp.

There is much that is still not known about the way sound propagates in the sea over great distances. The designer of future long-range sonar equipment is in urgent need of answers to such questions as to how well sonar signals are preserved in amplitude, frequency, and phase after traversing paths which are many miles long.

Prior to and during 1960 most long-range propagation experiments were performed using explosive charges even though it was realized that the shock wave of an explosive signal is not equivalent to a pulsed signal. In 1960 a sound projector designed and built at the Bendix Research Laboratories for the Office of Naval Research was placed on the ocean bottom at a depth of 200 fathoms at a point off the coast of an island in the Bahamas. This installation permitted, for the first time, continuous long-range propagation measurements to be made between a fixed deep-water source and a fixed deep-water receiver. Some early results were reported in four papers presented by Nichols and others of the Bell Telephone Laboratories at the October Acoustical Society meeting and at the classified Navy Symposium which followed. Nichols reported continual short-term fluctuations of appreciable magnitude having periods of five to ten seconds. This result in itself suggests serious problems in the use of standard correlation techniques for long-range sonar.

In the coming year it is expected that a much more intensive study of the long-range propagation unknowns will be undertaken since the recent results show that any hardware design will have to await a sorting out of the factors which cause the wide amplitude and phase fluctuations observed. Formidable as the problems in the use of correlation now appear, they would at least have the possibility of being overcome when it is learned *why* the fluctuations occur. Only with this knowledge can sound decisions be made on such alternatives as narrow band vs. wide band, high frequency vs. low frequency, short pulse vs. long pulse and so forth.

★ ★ ★

Hopes Held For Awareness Of Undersea Potential

By Dr. Waldo K. Lyon
Head, Submarine and Arctic
Research Branch
U.S. Navy Electronics Laboratory

Not being a soothsayer, nor having the imagination of Jules Verne, I can only say what I hope to see during 1961. In 1960, a new public awareness began to show — an awareness for the now cardinal importance of the undersea to the survival of the Free World Nations. With POLARIS, the balance of power, hence man's hopes for peace, went beneath the sea's surface, the inner space with which only a relative few in industry, science or the military have even a cursory acquaintance, least of all experience. This year, nuclear submarines demonstrated that they could routinely operate anywhere within the Arctic Ocean, *winter* or summer; the historic Frozen Sea has become the submariners' private sea. Within the year, a bathyscaph took man to the deepest part to give access to the entire volume of the sea. The new awareness brought before Congress the Marine Sciences and Research Act and brought into being this new publication, Underwater Engineering.

In 1961, I hope we shall realize that to command ASW means to command by submarine, that the protective screen for the surface ship means the friendly submarine beneath, viz. to command the sea now means to command the undersea and the air above. In 1588, spectators watched the breakup of an Armada and the death of a seapower. The undersea may have no witness, but as great a consequence.

To command the undersea means to understand it, and, therefore, we shall see more unique experimental submarines and more use of the submarine to study the sea, its boundaries, and the fish that live in it.

★ ★ ★

1961 Is Crucial Year For ASW Field Growth

By Dr. Maurice Nelles
Vice President Engineering
American Electronics, Inc.

In the history of underwater engineering, 1960 will be the chapter where technical interest in the ocean became an explosion. The possibilities of transportation on land, on sea, and in the air had been exploited but the even greater possi-

bilities of new conveyances in the ocean were brought into focus. The importance of the ocean as an ambiant media for engineering designs became significant. Engineers, whose thoughts had been concerned with low pressures, high temperatures, and non-corrosive environments, began to rearrange their thought patterns to master high pressures, liquid phase, and corrosive media in which their devices must operate.

The deep ocean suddenly received major emphasis as an unexploited and even unexplored place for military advantage. Many major corporations created large divisions or expanded small groups for underwater research to prepare to be competitive for the many billions of dollars which will be spent in the future for underwater military and civilian equipment. Relatively little of engineering and scientific importance was accomplished in 1960, for this was the initial part of the learning period. The next year, 1961, will produce some work of significance, but much of the accomplishments will be the completion of laboratory ships, tools, and instruments, to work in and to investigate the ocean. The deep ocean (below 1000 ft) will still not receive the attention it deserves. Investigations will be started on the interaction of structures and water under wide ranges of pressures and velocities. Studies on the properties of the ocean as a media for the transmission of sonic energy will be continued, but many new techniques of identification and communication will be tried. Underwater electronics will become much improved in design, sensitivity, size, and reliability.

1961 should be the year when preliminary ship design loses its domination by insurance and regulatory bodies and bold new advanced concepts can be developed and tried. New power plants can be applied and the many engineering and scientific developments in other fields can be included in ship design.

The biggest problem in 1961 will be to divide the funds which are available for oceanic work in such a manner that old perfunctory project plans will not dominate to the extent that money will not be available for obtaining basic design data for the future. We will be in a benthos race of even more importance with the space race, and whether we are first, second or third, will depend on what we do in 1961. A hundred million dollars wisely spent now will relieve us of crash programs and billion dollar expenditures in 1963.

★ ★ ★

A Prime UE Need Is Accurate Instrumentation

By T. R. Thoren
Vice President — Engineering
Pesco Products Div.
Borg-Warner Corp.

Accurate instrumentation is one of the prime requirements for scientific exploration in any field. Electrically-powered instruments provide many advantages in undersea observations and measurements because they combine the merits of accuracy, recording, storage of data, and the possibility of unattended operation for long periods of time. The duration of unattended time depends, of course, directly on the life of the electric power source. It is desirable that the unattended life shall be in many months, and in some instances, years. This requirement imposes a severe handicap on conventional sources of electric energy such as isolated batteries and the various forms of generators that employ chemical fuels.

Studies of the energy in sea waves have lead to the conclusion that the amount available at an anchored buoy is sufficient to consider transforming it into electrical energy to charge a battery. Several methods for converting sea wave energy have been investigated. A working model of one promising type has been constructed and tested to prove feasibility. Continuation of this work in 1961 is expected to result in the fabrication and testing of a full-scale prototype.

Another field of current interest is the improvement of apparatus for far-ranging human divers making direct observations and performing missions that can best be done by a man. Investigations are underway on the feasibility of an integrated system to provide an unenclosed underwater swimmer with a combination of several necessary functions to extend the period of time underwater . . . to as much as several days. The system would also provide for information acquisition and evaluation, and for personnel emergency propulsion. It would be responsive to change in depth and would automatically control the breathing system, temperature, and buoyancy as well as the rate of descent and ascent consistent with the remaining breathing supply to return the swimmer to the surface with full utilization of his physical capabilities. The analysis of such systems will continue in the coming year, the ultimate goal being the development and integration of various components into a complete system.

★ ★ ★

Oceanography Stimulates Congressional Interest

By Dr. Edward Wenk, Jr.
Senior Specialist in
Science and Technology
Library of Congress

National leaders of both political parties have noted the emerging significance of science and technology as an essential ingredient of our national security, and oceanography has been identified as one of the fields currently warranting attention. In light of the arguments for expanding the national program in the ocean sciences, coupled with a widely prevailing sense of urgency, the topic has received unprecedented


Dr. Maurice Nelles


T. R. Thoren

attention from both the executive and legislative branches. Eight different bills were placed before the 86th Congress, according to their preambles, with the intent of assuring an enhanced posture in oceanography by the formulation of a unified program, by adequacy of funding, and by the establishment of a statutory base for coordination of the various Federal agencies concerned.

Congressional committees having jurisdiction have studied the various proposals advanced by the National Academy of Sciences, by the Office of Naval Research, and by the Interagency Committee on Oceanography. Extensive hearings were convened during both sessions of the 86th, and testimony was solicited from numerous government officials, scientists, and industrial leaders having competence and interest in the field.

Generally speaking, the bills were supported by the scientific community; they were opposed by government officials on the grounds that adequate statutory authority exists for undertaking research by various cognizant agencies, which in the aggregate represents a national program, that coordination is being effected by the Interagency Committee on Oceanography, and that oceanography should not be singled out for special legislation because of the imbalance that may be introduced in the other fields.

Dr. Edward Wenk, Jr.

Only one bill (S. 2482, HR 8611) concerned with removing geographical limitations on jurisdiction of the Coast and Geodetic Survey passed.

The omnibus bill that bears the name of its sponsor, Senator Warren G. Magnuson, was approved as amended by the Senate and on June 25, 1960 referred to the House Committee on Merchant Marine and Fisheries. It was not subsequently reported out.

The factors which stimulated Congressional interest in oceanography remain.

What study or legislative action the 87th Congress will undertake can now only be conjecture. Reconsideration would need to take into account any developments that have transpired since the hearings of last year. In any event, issues confronting oceanography are sure to be examined in the broader context of the entire national program of research and development, including:

1) Identification of national policy regarding scientific research;

2) Adequacy of present patterns of government organization and management relating to Federal programs;

3) Mechanism for identifying fields that are undernourished and require stimulating in the national interest; and

4) Development of policies regarding industry-government relationships in science and technology.

★ ★ ★

airborne bathythermograph:

boosts sonar device effectiveness

By Donald E. Perry

JACKSON, Mich.—Sparton Electronics, a division of Sparton Corp. has developed a Bathythermograph Transmitter Set and a Signal Data Converter which may be integrated with existing equipment to form an Airborne Bathythermograph System. Developed under contract from the Bureau of Naval Weapons, the system has a capability of determining sea water temperature information in the range of 35 degrees F to 85 degrees F at depths of zero to 500 ft.

A Bathythermogram, or a graphical record of temperature versus depth, can be obtained approximately four minutes after launch from the aircraft.

Sparton, according to DeLoy G. Monroe, Chief Engineer of ASW, has been conducting field tests on the Airborne Bathythermograph Systems for several months. Although actual data has not been made available, Monroe reports that preliminary results have been satisfactory.

Major step — Development of an Airborne Bathythermograph is regarded as a major step to increase effectiveness of sonar devices in detecting underwater objects, particularly in the presence of thermoclines or temperature interfaces.

Temperature anomolies refract or deflect sonic transmissions. It has long been a problem to accurately determine their existence, location, and severity in order to get maximum benefit from sonar information.

If temperature-depth characteristics of a given sea area can be accurately analyzed by a bathythermograph, the depth and nature of a thermocline can thus be accurately determined along with sonic transmission characteristics.

Actually, two new equipments have emerged from the BuWeps development program initiated early in 1959. The first is a Bathythermograph Transmitter Set AN/SSQ-36 (XN-1). Second is a Converter, Signal Date CV-801 (XN-1) ARR.

Monroe, who has been with Sparton for 32 years, explains the operation of the Bathythermograph Transmitter Set (BTS) and the converter, like this:

An expandable airdropped device, it is housed in a standard-size sonobuoy case, permitting it to be launched from a standard Sonobuoy Aircraft dispenser. Upon being launched, four auto-rotational blades open to stabilize and slow its descent to the water. On water impact, a descent mechanism is jettisoned, the bottom closure is released, and sea water enters the battery compartment. After water entry, the BTS assumes a floating attitude that allows a one-quarter wave transmitter antenna to project above the surface of the water. A primary battery is activated by the sea water and, after a short warm-up period, the VHF transmitter starts to emanate an unmodulated carrier. (Fig. 1)

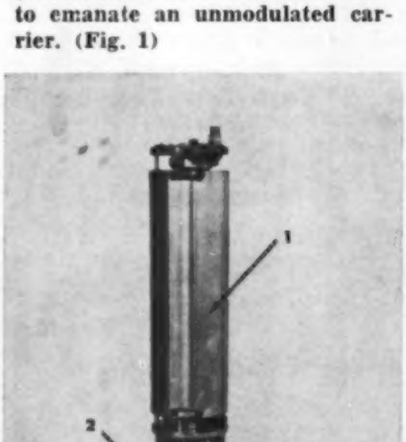


Fig. 1. Bathythermograph transmitter set, AN/SSQ-36 (XN-1). Equipment with housing removed: 1) electronic assembly, 2) sea water battery, 3) cable reel assembly.

An electro-mechanical device then releases a temperature sensor from the floating BTS and the sensor starts descent at a constant velocity. The sensor is electrically connected to the floating portion of the BTS by a small two conductor cable.

At the same instant that the sensor starts its descent, an audio signal with a frequency proportional to water temperature surrounding the sensor is applied as frequency modulation to the transmitter. After the temperature sensor has had time to descend to desired depth providing water temperature information during the course of its descent, primary voltage is removed from the VHF transmitter and transmission ceases. The BTS continues to float until a scuttling plug dissolves and allows it to sink.

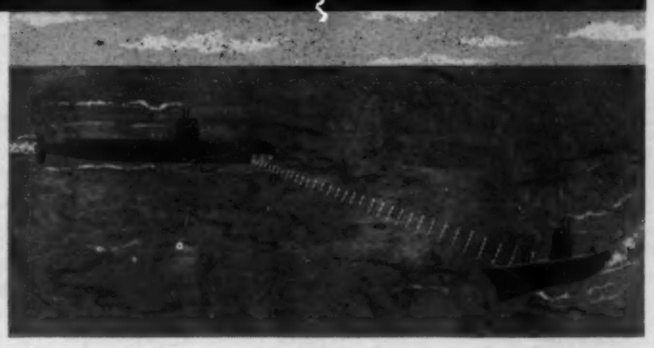
The converter — The airborne portion, or receiving end, of the system consists of a standard Sonobuoy Radio Receiving Set, a strip chart Recorder commonly employed in present day airborne Magnetic Anomoly Detection systems, and the Converter.

Switching functions are incorporated within the Converter to provide a means of borrowing Radio Receiving Set and Recorder from their normal system usage for the short period of time required to obtain a Bathythermogram.

Manipulation of a single control on the Converter prior to launching the airdropped BTS, places airborne portion of the system into operation. After a Bathythermogram is completed, the control is placed in its original position and normal use of Radio Receiving Set and Recorder can be continued.

Frequency modulated VHF signals emitted by the BTS are received by the airborne Radio Receiving Set which demodulates the signal and provides an audio output signal. The frequency of the audio signal, as previously stated, is proportional to water temperature surrounding the BTS Temperature sensor.

The recorder — The converter re-



LING'S SUPER POWER MODULAR SONAR SYSTEMS DELIVER MORE WATTS PER CUBIC FOOT

Ling delivers more power for shipboard use with some of the most compact amplifier modules built today. Ling's line of super power modular sonar systems can be built to suit any commercial or Mil-Spec application. Drawing on its extensive experience in producing liquid-cooled amplifiers, Ling produces exceptionally compact and efficient packages in modules to suit any shipboard application. Three ruggedly constructed, easily maintained cabinet modules, 16½" x 19" x 72" each, make up a basic system which readily expands to meet new requirements and which passes through *submarine* and *surface vessel hatches* with ease. Cabinets house all control circuitry, water-cooled heat exchanger, complete interlock and overload protection, and feature a full complement of front panel meters. For information on Ling Sonar Systems, write Dept. UE-161 at the address below.

LING·TEMCO ELECTRONICS, INC.

LING ELECTRONICS DIVISION

1515 SOUTH MANCHESTER, ANAHEIM, CALIFORNIA • PRospect 4-2900

Circle Reply Card No. 18

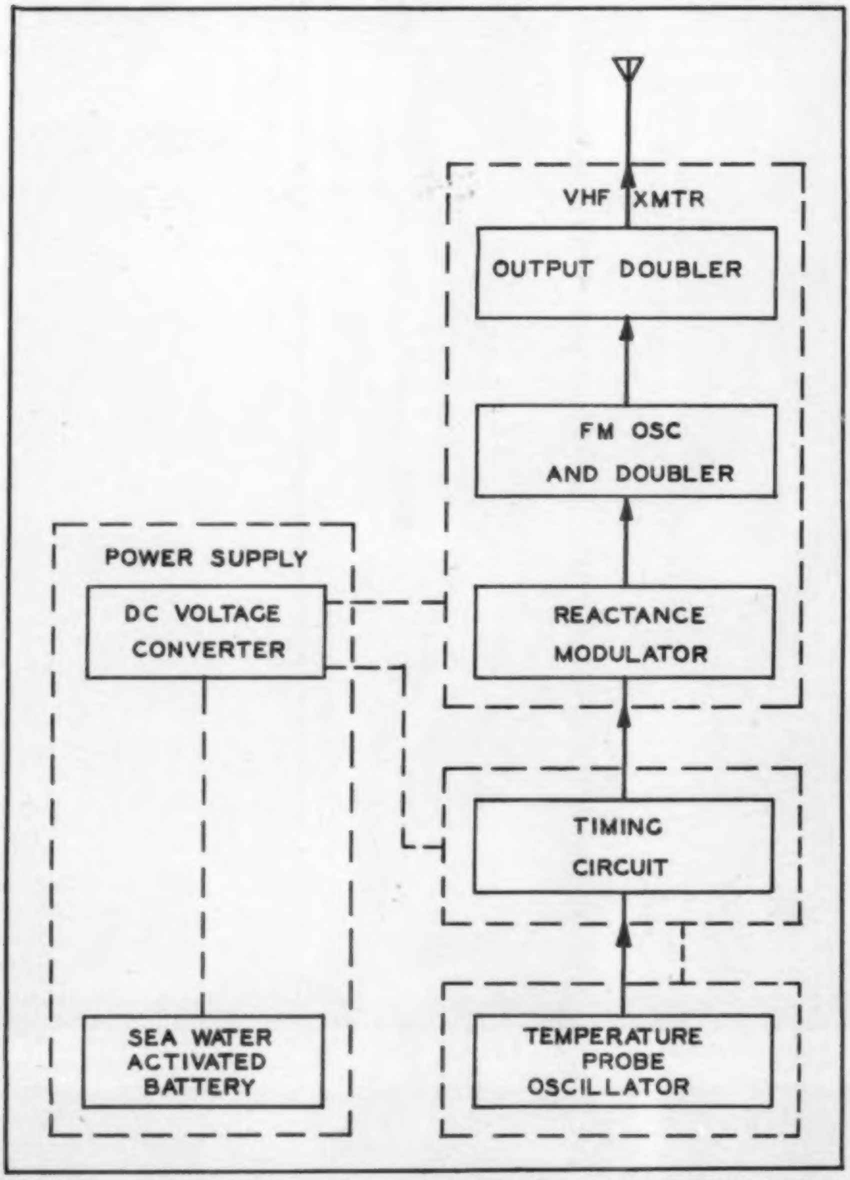


Fig. 2. Block diagram of bathythermograph transmitter set, AN/SSQ-36 (XN-1).

ceives the audio signal from the Radio Receiving Set and converts it to an output voltage proportional to water temperature. Output from the Converter is in turn fed directly to the Recorder where voltage developed by the Converter is visually displayed on a recording chart.

With recorder chart drive adjusted to a rate of motion proportional to the temperature probe sinking velocity, a permanent recorded trace of temperature-depth information is made on the recorder chart paper.

After the recording is completed, a transparent overlay with temperature and depth scales printed on its surface is positioned over the recorded trace. This permits visual observation of the temperature versus depth data, or bathythermogram, of the water into which the BTS was deployed.

As illustrated in the block diagram (Fig. 2), the BTS employs a VHF transmitter consisting of a reactance modulator, a frequency modulated oscillator and doubler, and an output doubler capable of producing frequency modulated signals that are radiated from a quarter-wave antenna at carrier frequencies between 162 Mc/s and 174 Mc/s.

A transistorized ac to dc power converter operating from a 13 volt sea water activated battery provides +B voltage for operation of the VHF transmitter. A simple timing circuit, employing two thermal time delay relays, controls the sequence of events which occurs within the BTS.

Bridged-T Network — Transducing water temperature to a signal that can be used to frequency modulate the VHF transmitter is accomplished by an oscillator, whose frequency is controlled by a temperature sensitivity resistance device. The oscillator is a two transistor dc amplifier circuit with a thermistor in a frequency determining bridged-T-feed-back network.

A combination of fixed capacitors, fixed resistors, variable resistors, and a thermistor form the bridged-T network which is connected from the emitter of one transistor to the base of the other transistor. The resulting negative feed-back path acts to reduce the amplifier gain. A minimum of feed-back occurs at the notch frequency of the bridged-T; and oscillation is sustained at the notch frequency.

Additional non-frequency sensitivity feed-back networks are used to stabilize the amplitude of oscillation of the oscillator and to insure against undesired frequency changes due to component variations.

A transformer in the temperature sensor oscillator circuit provides a means for utilizing the two-conductor cable for signal transmission from the oscillator up to the floating portion of the BTS and transmission of dc voltage down to the oscillator.

The oscillator is adjusted to provide a nominal output frequency of 1500 cps at 35 degrees F and 2500 cps at 85 degrees F. A linear relationship exists between these two end points, and a 1 degree F change in temperature results in an oscillator frequency change of 20 cps. Accurate control of end-points is maintained by individually calibrating each oscillator at temperature extremes and at mid-range during manufacturing process.

After all necessary calibration ad-

Fig. 3. Bathythermograph transmitter set temperature probe.


aboard the Triton...

justments are completed, the temperature probe circuitry is encapsulated within a housing. Encapsulation ensures mechanical rigidity and prevents leakage of sea water into the unit even when exposed to the pressures encountered at extreme depths.

Stowage — Other interesting features of the BTS are concerned with stowage of the probe and its connecting cable as well as the means of establishing depth information. The connecting cable is held tightly coiled against the outside of a cannister by four leaf springs which are permanently attached to one end of the cannister and held in place by a retainer ring.

This effectively prevents wire dereeling prior to water entry. The springs are released upon entry into water, and only a small amount of

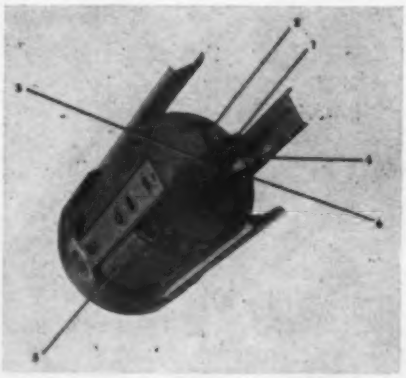


Fig. 4. Lower unit assembly showing details of temperature probe release mechanism, bathythermograph transmitter set: 1) release lever, 2) tension spring, 3) fuse wire and protective sleeve, 4) release pin, 5) cable reel assembly, 6) insulating block.

force is then required to strip the cable from inside of reel. The temperature sensor is retained in an inverted position inside the cable reel until it is ejected upon impact of the BTS with the water.

Simplicity in the communication link between the BTS and the airborne portion of the system, together with compatability between this system and equipment used in other ASW systems is considered by Sparton as more important than complete sophistication in the transmission of depth information. Therefore, only information concerning water temperature is transmitted on a continuous basis and elapsed time is relied on for the establishment of temperature sensor depth.

This requires transmission of an accurate starting signal simultaneously with the temperature sensor release and essentially constant temperature sensor sinking velocity.

The starting signal requirement is fulfilled by the simple expedient of applying modulating voltage simultaneously with the release of the sensor.

Temperature probe — Constant temperature sensor sinking velocity is attained by using a body the shape of which is illustrated in Fig. 3. Sparton arrived at this shape by calculating an approximate solution and arriving at the final details through empirical data obtained from controlled test observations.

In order to place the temperature probe in an attitude that will permit attainment of terminal velocity in as short a time as possible, it is restrained a short distance below the bottom of the BTS after water impact and prior to release. This action also serves to correct in a measure for thermal effects time constant in the thermistor element.

The temperature sensor is released by a mechanism with two levers held closed by a length of fusible wire (see Fig. 4). When voltage is applied, the wire fuses so that springs separate levers, and a nylon pin, with restraining cord attached, falls through an insulating block.

The Converter unit used in the airborne end of the system processes the demodulated VHF signal to a signal suitable for deflection of the pen-motor in the recorder.

Basically, the converter must produce 1 milliamp of output current for an input signal frequency of 2500 cps and no output current for an input signal frequency of 1500 cycles.

Sparton points out that the square hysteresis loop characteristic inherent in some of the grain-oriented nickel-iron alloys remains stable with time and temperature. Therefore, by constructing a transformer with this material as the core, and driving the transformer core to saturation first in one polarity and then in the alternate polarity, it was possible to make available pulses of constant energy on a secondary winding of the transformer. These constant energy pulses are rectified and imposed across a direct current indicating device. A constant current generator whose output is equal and opposite to the current produced by the pulse generator and rectifier circuit at a signal frequency of 1500 cps is connected in parallel with the pulse generator and rectifier across the recorder prn-motor. This circuit arrangement produces the required output current versus input signal frequency characteristics.★

Greater range for undersea weapon systems with CLEVITE PZT®

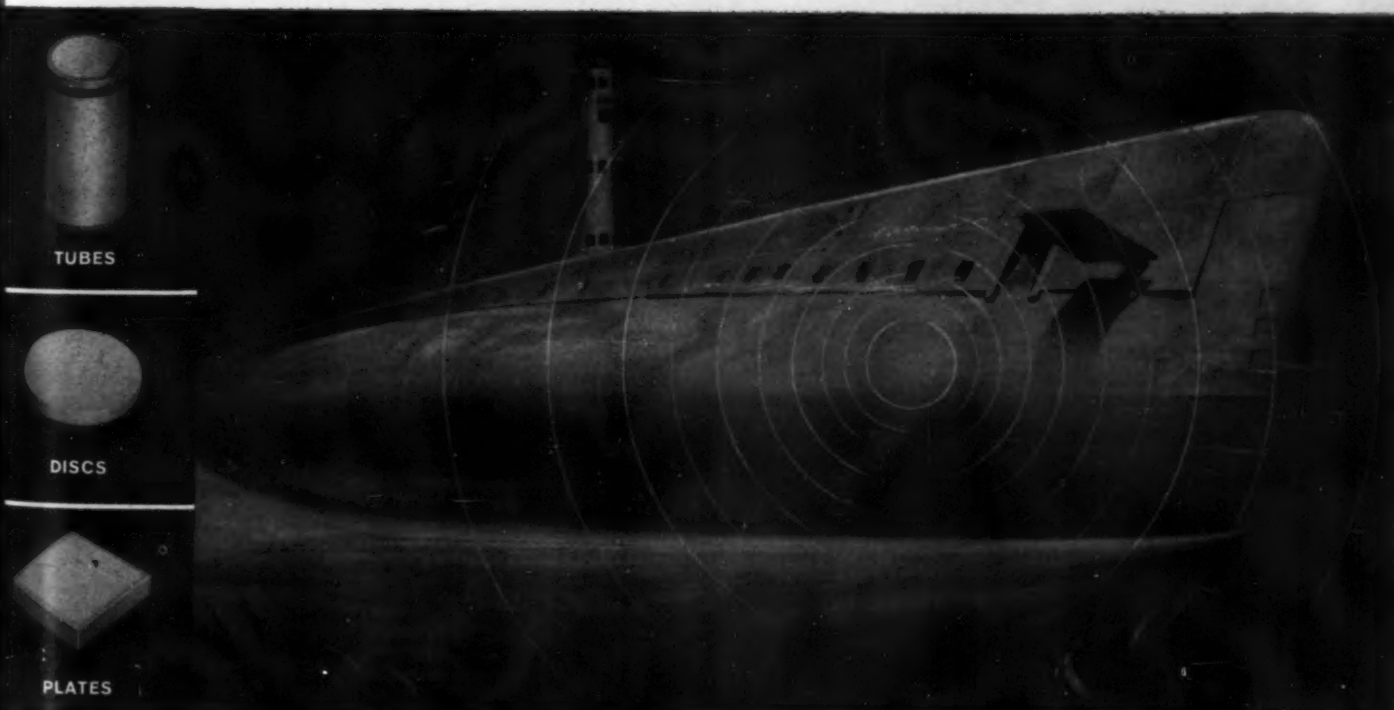
Clevite offers the most advanced piezoelectric ceramics for sonar and sonobuoy applications . . . "PZT-4" for transmitting, "PZT-5" for receiving.

Clevite "PZT" transducer elements give you the same acoustic output at less than half the volume. You get *twice the power-handling* capability of barium titanate (Clevite Ceramic B®), *higher piezoelectric coupling* coefficient, lower dissipation factor and more efficient high temperature operation (Curie point over 300°C).

Clevite supplies "PZT" elements for detection and guidance equipment on the atomic submarine fleet, user of the world's largest operational sonar systems.

Plan to use Clevite "PZT" in your present and future undersea weapon designs. Standard stock sizes and custom shapes *available in quantity*—and with *uniformity* never before attained in piezoelectric ceramics.

Write today for bulletin 9244.



CLEVITE ELECTRONIC COMPONENTS

DIVISION OF

CLEVITE CORPORATION

3405 Perkins Avenue Cleveland 14, Ohio

Field Sales Engineering Offices:

2130 Millburn Avenue, Maplewood, New Jersey

1915 N. Harlem Avenue, Chicago, Illinois

3402 W. Century Blvd. Inglewood 2, California

Circle Reply Card No. 21

research ships dock at front door:

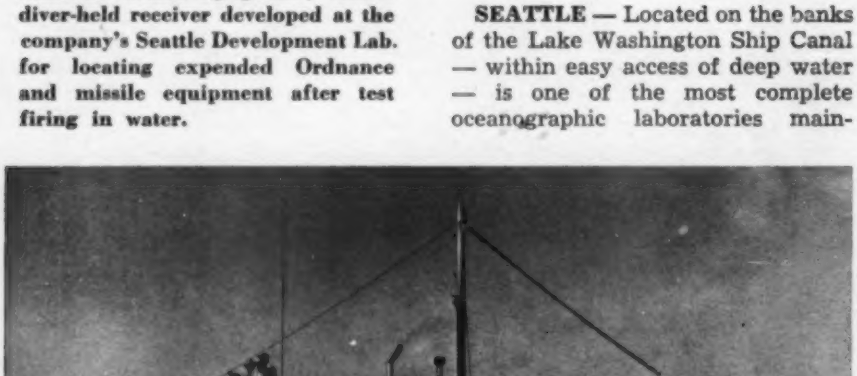
sdl seeks undersea answers

A Minneapolis-Honeywell engineer, with full Scuba equipment, tests a diver-held receiver developed at the company's Seattle Development Lab. for locating expended Ordnance and missile equipment after test firing in water.

honeywell's lake washington lab sends its ships to nearby deep water for testing of ASW and USW equipment, and to investigate special problems in oceanography

UE Staff Report

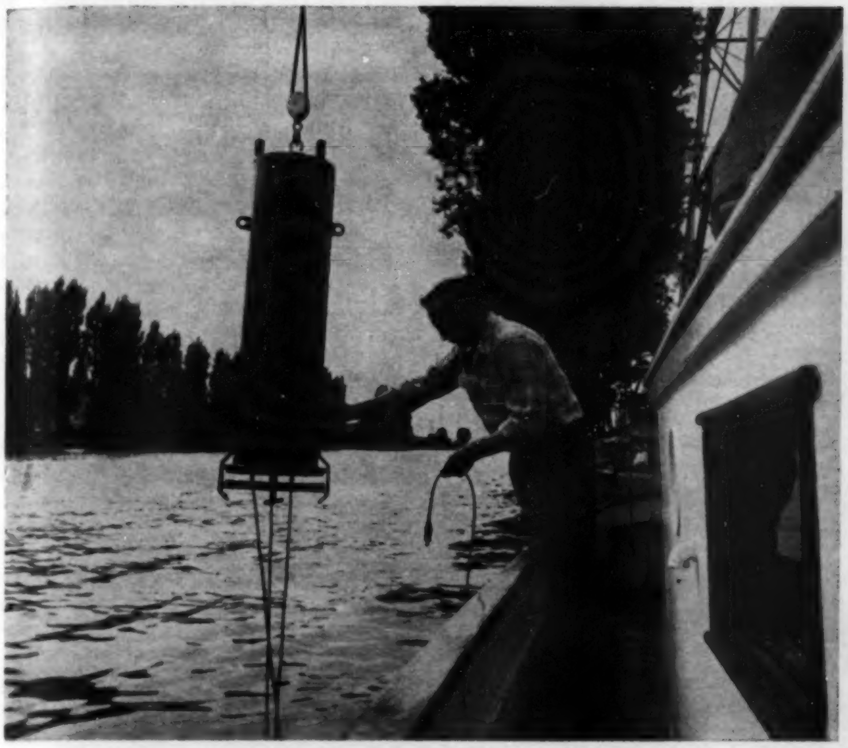
SEATTLE — Located on the banks of the Lake Washington Ship Canal — within easy access of deep water — is one of the most complete oceanographic laboratories maintained by a private corporation: Minneapolis-Honeywell's Seattle Development Laboratory.



Research vessel M/V *Neper* is used in ASW and underwater engineering studies at Honeywell Seattle Development Lab.

Unclassified products of the Honeywell Lab, which has three research ships docking its front door, include: digital communications and data transmission systems, microwave sensing devices, support equipment instrumentation, sea-range instrumentation, and underwater ordnance including undersea ranging and tracking systems, pingers and receivers for acoustic location systems, ASW training and simulation equipment, underwater telemetry, transponders, sound projectors and hydrophone arrays, low-frequency high power transducers, and high-definition pulse sonar systems.

DORU Organized — A Deep-Ocean Research Unit (DORU) was set up at SDL last June to investigate special problems in oceanography. DORU, underwritten by corporate funds, is directed by SDL management and has access to the Lab's facilities and supporting personnel. Its current investigations include earth-field magnetometeric



Acoustical gear is lowered into the water from the Honeywell research vessel, M/V *Neper*.

problems, acoustic measurements of reverberation and ambient noise, instrumentation for high-pressure environments, studies in explosive echo-ranging, and research on underwater phenomena associated with other advanced deep-ocean ASW devices.

The most significant development from the research unit to date is a taut-wire subsurface buoy which will serve as an underwater instrumentation platform for monitoring and recording various ocean parameters, such as ambient noise background. This recoverable buoy would enable oceanographic researchers to extract information of greater quality and quantity than was possible by the old method of stationing a vessel in open ocean for a certain period of time or by use of free-floating buoys.

Front door dock — SDL's location on the banks of Lake Washington Ship Canal gives it ready access to nearby deep-water test sites. Fresh water to a depth of 200 ft and salt water to a depth of 900 ft are about half an hour's boat trip from the front door. The Lab is also close to Navy's Puget Sound Installations such as Naval Torpedo Station at Keyport, Puget Sound Naval Shipyard, and Dabob Bay Torpedo Test Site.

The three ship laboratories operated by SDL are the *M/V Neper*, a 47-ft deep-draft vessel, the *Deci-Belle*, a 50 by 20-ft experimental barge, and a recently purchased 65 by 25-ft powered twin-screw catamaran.

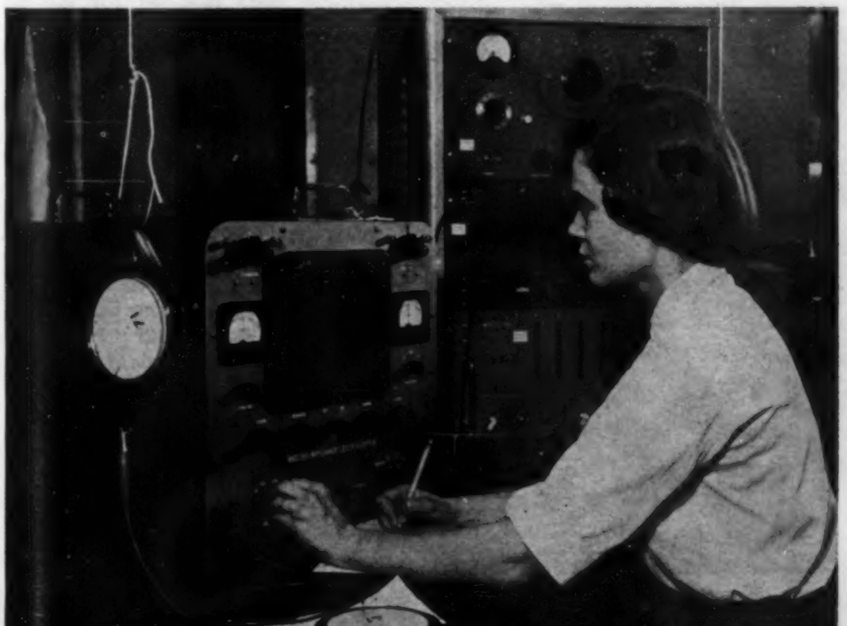
The *Deci-Belle*, fully instrumented as a floating test laboratory, is equipped for fixed-location transducer testing, has three wells cut through her hull, and heavy-duty power hoists for rapid handling of transducers. Off-shore ac power is provided by a diesel-generator unit.

The *Neper* is fitted out with an auxiliary power plan, automatic pilot, two-way ship-to-shore radio, two high-frequency walkie-talkie communication sets, four hull fittings for transducer work, power winch and hoist boom, in addition to meters, oscilloscopes, and living quarters for a six man crew.

The catamaran is designed for acoustic testing which requires a high degree of flexibility, such as current work with high-power underwater transducers.

History — Seattle Laboratory's entry into the underwater and ASW field resulted principally from the development, refinement, and modification of its earliest commercial item — the Honeywell "Sea Scanner" — a short-range (1600-ft) "searchlight" type sonar, and its military counterpart, the AN/SQS-28 (V) Detecting-Ranging Sonar Set, developed for the Coast Guard. The "Sea Scanner" has been recognized for its frequent association with deep salvage operations.

SDL gained experience in subsystem and component design in 1955 with the award to Honeywell of the ASROC antisubmarine weapon sys-



Transducer elements are tested in Laboratory.

tem prime contract. The Seattle Lab's first duty was to develop an instrumented sea range at a test site off San Clemente Island.

Since then SDL has developed a fixed-location hyperbolic tracking range at Carr Inlet, Puget Sound, which provides submarine range and bearing to a fixed-location laboratory and supplements navigation by furnishing information to prevent collision with anchored hydrophone buoys. A range system was recently delivered for use at "Tongue of the Ocean" which enables a laboratory ship to obtain range and track data on a submarine maneuvering through the range.

SDL's capabilities in range work include X-Y coordinate tracking methods, hyperbolic tracking methods, both fixed and mobile ranges, 2-D and 3-D range studies, buoy-supported and bottom-moored hydrophone arrays, signal analysis, and the use of submerged recording buoys capable of sampling ocean variables over extended periods of time.

Present projects — Work presently in progress at Seattle Laboratory includes an extremely accurate synchronous clock-timer which generates acoustic pulses for tracking an underwater vehicle in a rectangular coordinate range. Two identical units are used, one on the vehicle and one at the tracking station. After synchronizing one with the other, they will emit pulses simultaneously with a known drift rate over requisite time span.

In order to furnish more effective calibration of test ranges under development, the Lab has carried on intensive studies of noise generated from moving underwater vehicles, impact noise, and the effects of oceanographic variables on sound transmission.

Several years ago, Honeywell sonar team devised a bomb-point-of-impact location system, and went on to determine optimum underwater acoustic signals from various types of small explosives. Result: a family of highly responsive hydrophones, resistant to extreme shock and pressure, developed to measure underwater explosions.

One development gained from hydrophone research is the Julie Target Simulator, an expendable Naval training tool which produces simulated submarine target echoes upon interrogation by explosive-type acoustic sources, allowing operating conditions to be simulated realistically.

Transducers — Since 1955, many problems relating to practical applications of the flexural-mode transducers have been solved at Seattle Laboratory. These include the construction and use of operational transducers with square, rectangular, and circular radiating surfaces. These studies have allowed the selection of optimum ceramics, mechanical structures, and bonding techniques, resulting in small, lightweight transducers with high electro-mechanical efficiencies and power-handling capabilities of several hundred watts per pound at two kc.

Investigations in the use of multiple-element stagger-tuned transducer arrays have yielded small-area transducers with broad bandwidth capacity. Another development has been a compact, low-frequency, high-power-output transducer of a free-flooding design which can be used in very deep water.

SDL currently has a contract from Navy's Underwater Sound Laboratory to develop an underwater research acoustic source capable of radiating ten kw at 100 cps. High-compliance piezoelectric bender bars in a "building-block" configuration are being used to meet design problems.

Rugged, miniaturized, self-powered sound sources or pingers, and portable, easily maintained receivers are produced by SDL to detect and locate expended ordnance and missile equipment after test firing in or over water. Virtually non-magnetic, these detection units may be operated from a small boat or carried by divers, and utilize either loudspeakers or earphones for signal presentation.

Dr. Theodor F. Hueter, author of 36 publications in the fields of acoustic propagation, transducer materials, and medical electronics, heads the Minneapolis-Honeywell Seattle Development Laboratory.

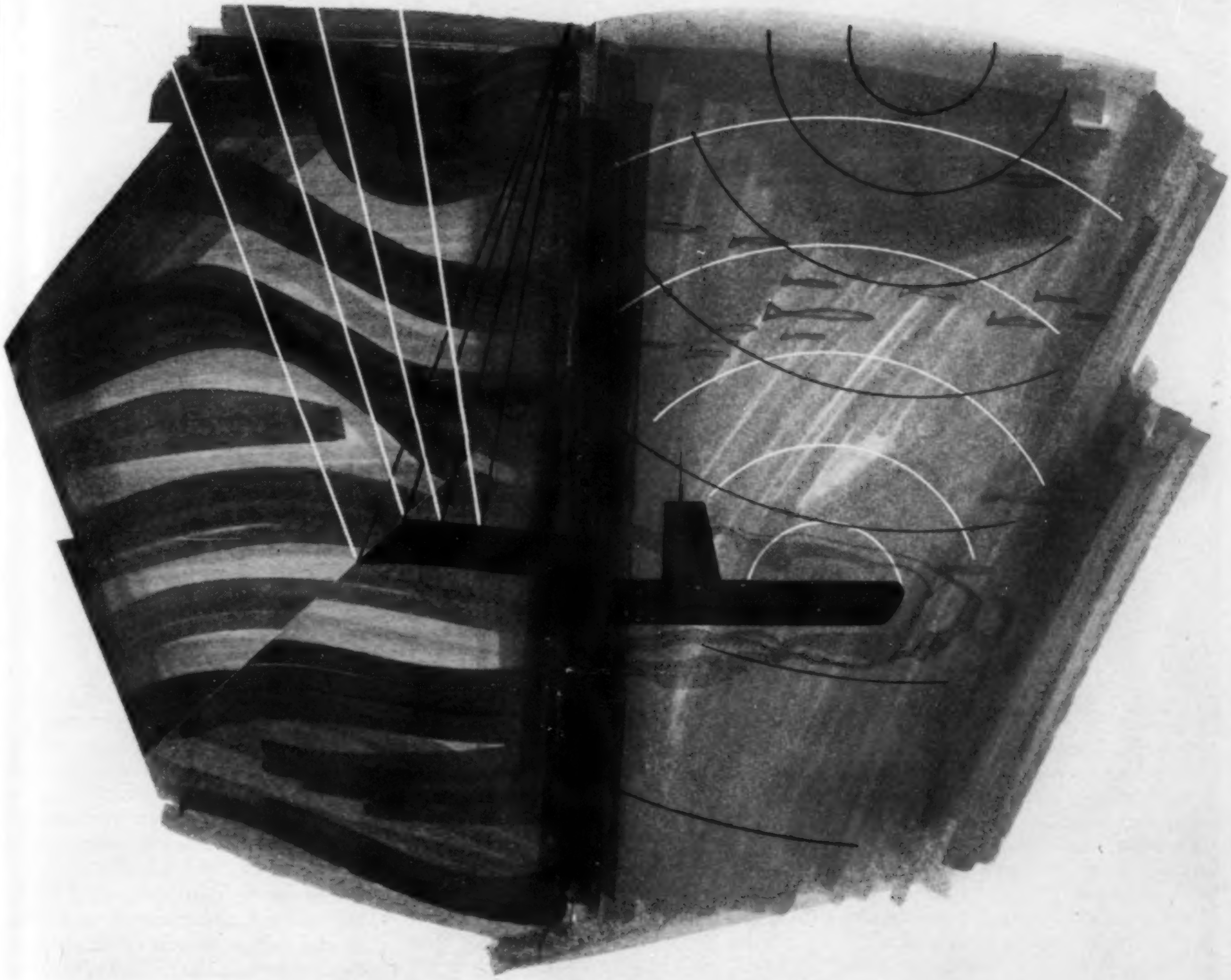
Acoustic systems — One example of an SDL-developed acoustic location system is that used with ASROC, which consists of a pinger attached to weapon being fired, a boat-carried receiver with hydrophones, a self-contained diver-held receiver with hydrophones. Operating at a frequency of 62 kc, system provides reliable location to ranges of approximately one-half mile and has assisted in recovery of objects buried in up to 40 ft of mud.

The system's sound source is designed to withstand water-impact of approximately 2000 G's, pings at a rate of one pulse per sec., and has a useful life of well over 200 hours before its standard commercial dry-cell batteries need replacing. Operation is initiated by means of a pressure switch which closes at water depths between five and ten ft.

Diver-held receiver used with the system has a directive receiver, amplifier, and audible 2-kc reproducer with self-contained battery pack. No external cables are required because receiver output is transmitted directly to the diver through water. A manual gain control is provided so constant directivity can be maintained at any distance from sound source. Although receiver was designed specifically for use at 62 kc, it can be modified to operate at other frequencies.

ASROC devices — Other devices developed for ASROC include a portable field test set for ignition and separation assembly, and a portable sonar transponder containing pulse-identity circuits which help discriminate between destroyer-initiated interrogation pulse and random ship noise. Another unit developed for ASROC and available for other weapon systems is the AN/WSA-1 Signal DATA Converter, a fully transistorized, solid-state device which integrates various bits of X-Y tactical information in the form of synchro voltages and presents this data as video symbols on an unmodified search radar PPI scope.

Manager of Seattle Laboratories is Dr. Theodor F. Hueter, an internationally recognized leader in underwater acoustics and physical ultra sonics. He was a key figure in Raytheon's design of the AN/BQQ-1 integrated sonar. He was a member of PROJECT ATLANTIS, and is a member of the New Devices Panel of the Academy of Sciences. SDL's assistant manager is Robert A. Crinkley, one of the pioneers of the ASROC development program.★



evaluation of asw equipment

By Capt. Thomas D. McGrath, U.S.N.
Commander, Key West Test and Evaluation Detachment

The cycle from inception to operational hardware of new equipments is initiated in the Office of the Chief of Naval Operations, where requirements are established and developmental responsibilities assigned. Such requirements may result from a recognized need, from fleet proposals, from studies, or proposals from technical agencies.

This cycle of research development, test, and evaluation for a major equipment has taken from six to seven years in the past. Of this time, evaluation has occupied six to nine months on an average. All these phases are the responsibility of developing agencies, except the last which is conducted independently by Operational Test and Evaluation Force, (OPTEVFOR), under Rear Admiral C. K. Bergin, with headquarters at Norfolk, Va.

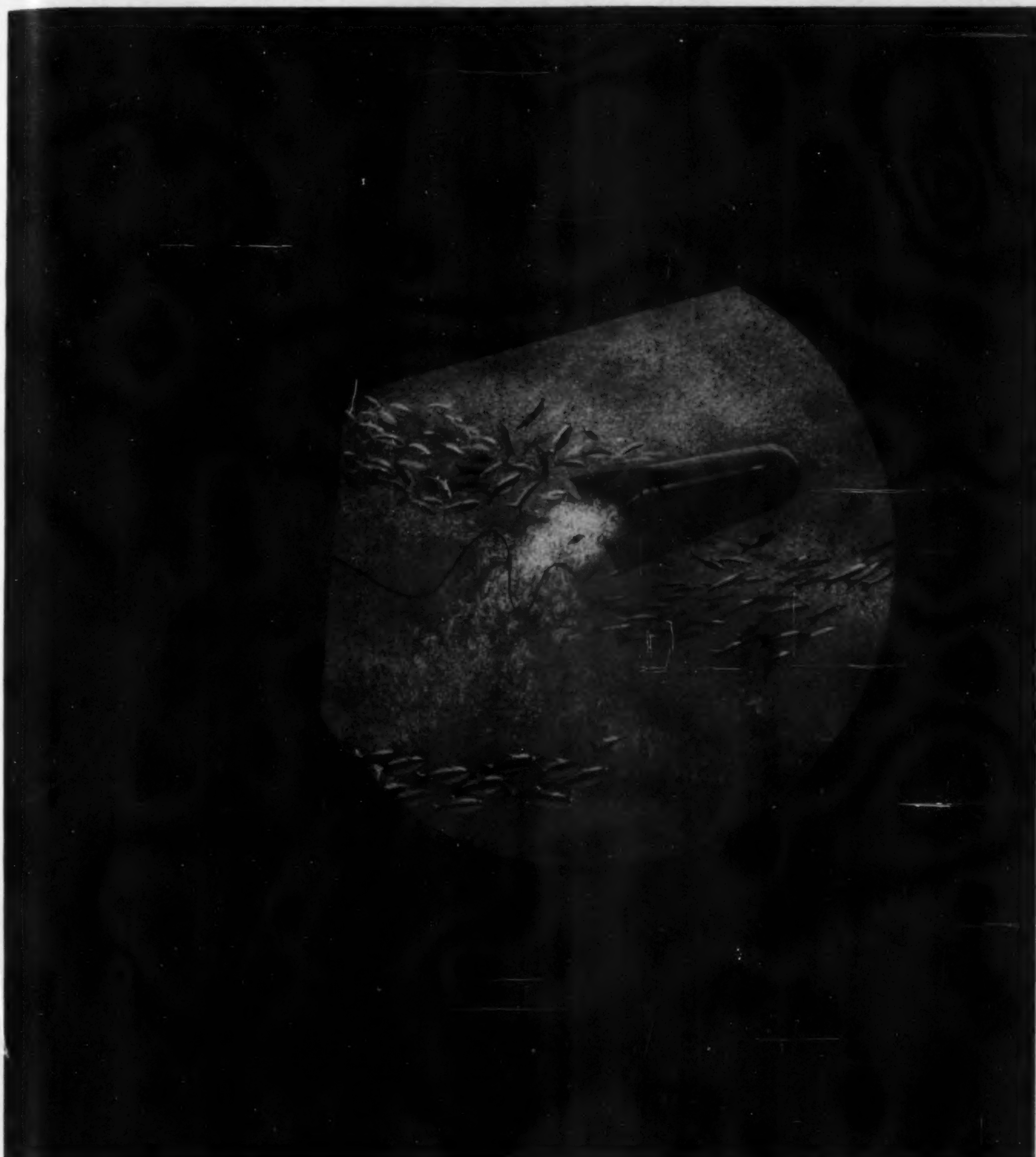
Special Commands —Included in his command are several specialized detachments for particular warfare fields. Three of these, Key West Test and Evaluation Detachment (KWESTEVDET), New London Test and Evaluation Detachment (NLONTEVDET), and Air Development Squadron ONE (VX-1) are primarily concerned in this area. Pacific Div. handles tests on the West Coast. By test is meant the technical test of equipments by the developing agency where fleet services or realistic environmental conditions are a requisite. Such tests normally precede operational evaluation and result in certification that equipment is or is not ready for evaluation.

The work orders to OPTEVFOR are project assignments originating in the Office of the Chief of Naval Operations. COMOPTEVFOR develops a project plan and reassigns the project to an appropriate detachment for prosecution. The detachment supplies supporting plans for analysis and data collection, writes necessary operation orders, conducts operations, analyzes results, and submits report to COMOPTEVFOR. That command reviews the report and transmits it to the Chief of Naval Operations, generally with a recommendation that equipment be accepted or rejected for fleet use.

OPTEVFOR functions as an independent product testing laboratory for new equipments — representing operating forces — to ensure that equipments can be operated and maintained by fleet personnel; that its capabilities and limitations are known; and its personnel training and logistic requirements fixed. In order to do this, detachments are manned by fleet personnel who come from the fleet and will return to it. Field engineers and company representatives are generally present, but during operational evaluations are not utilized until service resources prove unable to maintain operation.

Detailed Discussion — While this generalized summary is useful in

Aerial view of KWESTEVDET at Naval Station Annex, Key West, Fla.



process, a more detailed understanding can be gained by narrowing the discussion to Key West Test and Evaluation and its work. This detachment, housed in a converted World War II wooden barracks, on the Naval Station Annex at Key West, has about 40 officers and nearly 200 enlisted men. Of the officers, two are acoustical engineers and one has completed a post-graduate course in operations analysis. A representative of the Operations Evaluation Group (OEG) is assigned the command. Emphasis is more on operational competence rather than technical specialization.

Physical facilities include an electronics shop with requisite test equipment, a photo lab to process photographic data, a small combined machine, carpenter and metal working shop, a torpedo shop, and a mine shop.

Evaluation Ships — The *USS Sarsfield* (DD 837), *USS Saufley* (EDD 465), *USS Peregrine* (EMSF-373), *USS Shrike* (MSC 201), *USS Saliman* (ATF 161), and *USS Weatherford* (EPC 618) are under operational control of COMKWESTEVDET for project operations. Additional ships with equipment for evaluation are assigned for particular projects. Submarine services are supplied from Submarine Squadron TWELVE at Key West, or, where special types such as nuclear submarines are required, special assignment will be made by the Atlantic Fleet Commander. Normal aircraft services are furnished by Air Development Squadron ONE at Key West; special types by appropriate fleet commanders. These are the means available.

While the primary function of KWESTEVDET is operational evaluation of surface antisubmarine and mine warfare equipments, it has responsibilities also in developmental testing. Projects for the latter will be assigned when a developing agency requires tests that need realistic environmental conditions or fleet services. Planning and control of such tests remain the responsibility of the developing agency. The detachment only furnishes services and necessary coordination and direction to ensure efficient use of services and maximum accumulation of data. The results, analysis, and reporting are the province of the developing agency.

Since most equipments are assigned for test before evaluation, developmental projects serve to familiarize the command with such equipments, serve as training periods, and enable the command to suggest changes which, if not made, would prejudice equipment in subsequent evaluation. In many projects, tests and evaluation are combined in concurrent evaluation. This allows data to be used from both evaluations, and permits compression of time required. After a project has been assigned by CNO and reassigned to the detachment, the project plan becomes the bible for prosecution of project. These plans vary for each project, but as an example, project plan for a sonar will include:

I. **At sea tests to determine:** LATERAL range capabilities; semi-alerted range (max); alerted range (max); above and below layer ranges; minimum range; torpedo detection; echo to ping ratio; coverage rate; interference; classification capabilities; range and bearing accuracy; ability to maintain contact.

II. **Observations during above tests to determine:** figure of merit (energy into the water); reliability; ease of maintenance; casualty circumvention; adaptability; effects on habitability; electronic interference; spare parts requirements.

From the data collected and above observation, following requirements are determined:

I. **Personnel:** operating, maintenance, training, training aids and procedures.

II. **Operating:** completeness of controls and presentation, simplicity of operation, convenience, effects of shipboard environmental conditions.

III. **Tactical:** maneuvering requirements, restrictions imposed on ship regarding speed or maneuvers, operation applications.

The report will reflect analysis of data collected and a comparison with previous evaluations to form the basis for a recommendation that equipment:

1. Be accepted for service use.
2. Be accepted contingent on certain changes.
3. Not be accepted.

While evaluation of a system or weapon will follow the same principles, it is generally necessary to determine hit probability, weapon performance, and control accuracy instead of detection capabilities.

Problems in evaluating are being compounded by cost of hardware, increased target capabilities, increased ranges, and new homing weapons. Cost of hardware limits numbers available so that adequate sample size is difficult to obtain. Increase in target speed and depth capabilities increases variables to be observed; longer range weapons and sonars increase time per run, and result in either fewer runs or increase in time required for evaluation. Finally, weapons that once in water follow self-determined paths make reconstruction of the run extremely difficult. It is apparent that, for valid evaluation, a facility is required that can follow target, firing or searching ship, and weapons so that every run will yield a maximum of data.

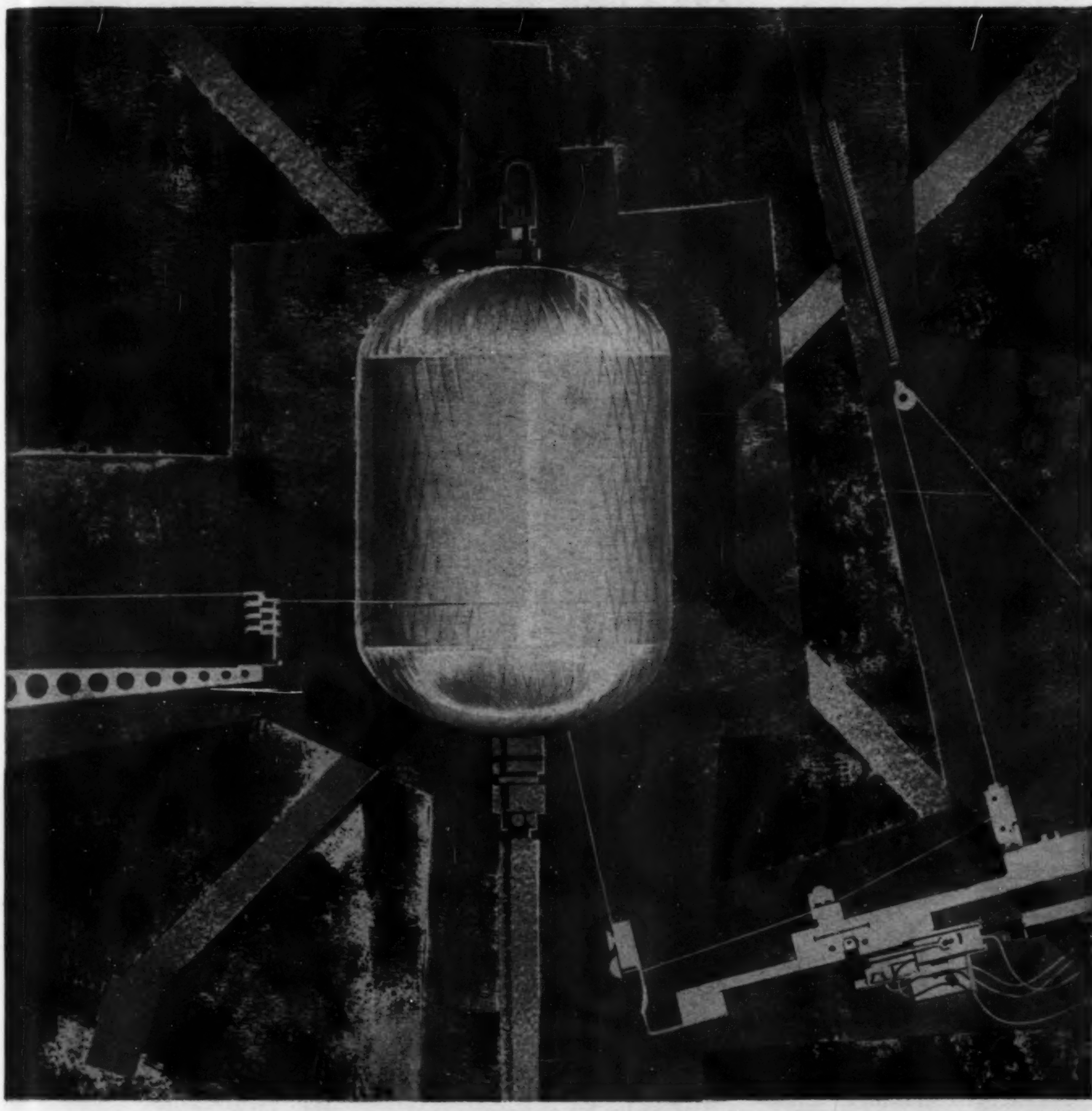
Future Importance — Operational evaluation in the past has been valuable in giving operating fleets better equipment, basic requirements for operation, and a starting point for tactical developments. In the future its value will become greater, and, though expensive and time consuming, will assume greater importance. As cost of weapons increases, ship will be able to expend few weapons in training. In addition, many weapons are designed to be used only once — and then in the war shot configuration. Consequently, operation evaluation will provide the only source of sufficient basic data for tactical development and operation. It is to be expected operational evaluations will be continued and will require greatly improved methods of data collection and analysis so that time required can be cut and results maximized.★

key west to host nsia meeting

A visit to the U. S. Naval Base, Key West, Fla., is being arranged by the National Security Industrial Association for March 1-3.

The two-day program will include a briefing by Commanding Officer, Fleet Sonar School; a tour of the School; briefing on new sonars and ASW weapons; tour of Key West Test and Evaluation Detachment; briefing on Advanced Undersea Weapons School Mission; and tour of current fleet AUW mock-ups, all on March 2. On March 3, visitors will board Navy ships for "At Sea" ASW demonstrations.

The number authorized for this meeting has been limited by Navy to one per company membership, on a first-come, first-served basis. Reservations close on Feb. 10. Invitations have been mailed to all NSIA members.



BRUNSWICK BI-AXIAL WINDING ENCASES ENORMOUS ENERGY!

In the field of rocket motor case construction, Brunswick's exclusive Strickland "B" Process (SBP) of fibre glass filament winding gives an S/D ratio as high as 2,000,000. Engineers are currently calling on Brunswick to provide up to 7,500,000 psi modulus for design allowables. SBP's unique bi-axial winding lays down filaments under tension first in one direction, then in the other (circumferential and longitudinal). As a result, SBP is particularly efficient for construction of closed-end cylindrical shapes and unusually contoured components. Current projects indicate the extremely large range of sizes possible – from 6′ to 12′. Tension winding pre-stresses cases to a rare degree, while allowing precise filament placement for exactly controlled uniformity of thickness and strength. The SBP exclusive automatic control of resin to glass ratio gives Brunswick outstanding uniformity of material composition. From complete in-house design and fabrication to final testing, Brunswick is ready to serve you. Find out more about SBP. Get detailed and documented information on its many unique features. Write or call: Defense Products Division Sales Manager, 1700 Messler Street, Muskegon, Michigan – today!

Brunswick

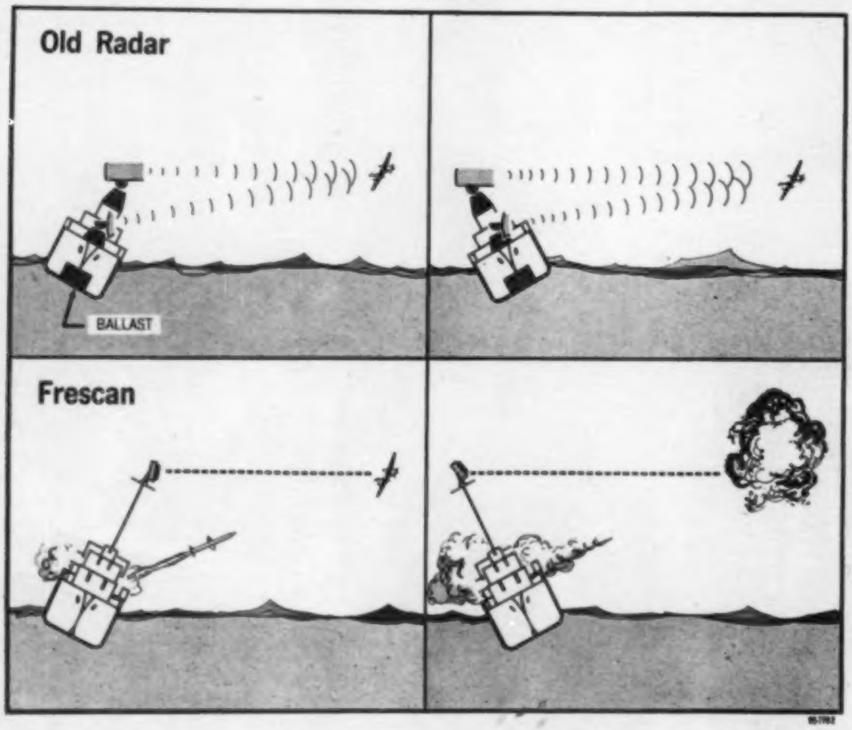
MAKES YOUR IDEAS *WORK*

Circle Reply Card No. 26

new u e products

U.S. Fleet Given 3-D Radar

Modern missile-armed cruisers and destroyers of U.S. fleet have



been equipped with the first seaborne electronic scanning radar capable of pinpointing simultaneously three essential target dimensions — range, bearing, and altitude.

Made by Hughes Aircraft Co., the Frescan, a lightweight, all-weather radar, uses a single antenna, transmitter, and receiver. It automatically flashes information on supersonic targets to information and control centers which fire interception TALOS, TERRIER, or TARTAR missiles.

Hughes characterizes the Frescan as having: instantaneous display of three-dimensional multiple target information; electronic pitch and roll stabilization; high flexibility.

All available power is concentrated in sharp, pencil-shaped beams of energy to accurately pinpoint targets at great distances. Range and height information is obtained by electronic scanning in a vertical plane in millisecs., while rapid rotation of the antenna supplies target bearing.

Circle Reply Card No. 101

Trouble Shooting Test Bed for Navy

Mobile gas turbine test stands and engine analyzers, engineered by The Garrett Corporation's AiResearch Manufacturing Div., provide a portable trouble shooting test bed for current or projected gas turbine engines built by AiResearch for Navy auxiliary power use.

The engine analyzers are furnished separately in "suitcase" configuration. They may be used independent of the stand to provide complete checkout of aircraft, trailer, or tractor mounted turbines. Used with the stand, they serve as its control and readout panel.

Test stand includes its own fuel and lubricant supply, a heavy duty starting battery and charger, and storage racks containing fittings to connect various turbine models to its telescoping exhaust stack.

Weighing 2100 pounds, the complete test unit is approximately 12 ft long by 6 ft wide. It is towed by standard Navy vehicles. The gas turbine engine analyzer weighs 45 pounds. Its portable case contains all instruments, controls, switches, indicating lights, and connections needed for complete, independent field maintenance and trouble shooting.

Circle Reply Card No. 102

Interlocks to Check Electrical Equipment

Three door interlocks featuring a maintained-contact actuator position for checking hazardous electrical equipment have been produced by Minneapolis - Honeywell's Micro Switch division.

The interlocks automatically cut power to electrical components when service door is opened and turn it back on when door is closed.

For checking equipment without using jumpers or cheaters, actuating plunger is pulled to the maintained-contact position to keep power on. When door is closed, actuator automatically returns to normal position.

Two series — 22AC and 23AC — differ in shape of mounting bracket and location of mounting holes. The 24AC model, which controls two separate circuits at the same time, uses two switches.

All three have thermoplastic actuating rods which are self-lubricating. They are available with tapped ends for adding extensions.

Switches are rated for 10 amps at 125 or 250 volts ac; .5 amp at 125 volts dc; .25 amp at 250 volts dc; .5 horsepower at 250 volts ac. Actual travel is approximately .250 in. on push; .187 in. on pull.

Circle Reply Card No. 103

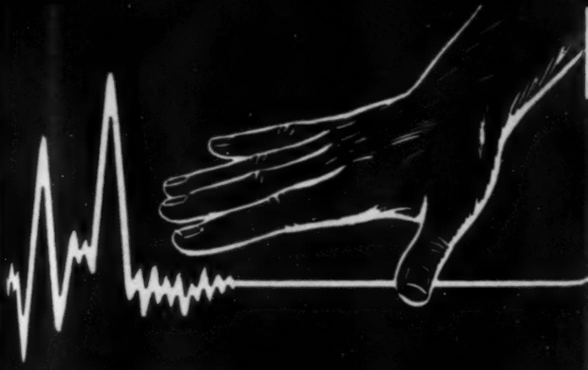
Miniature Filter Unit

A light weight, miniature filter assembly for fluid line systems, developed by Dumont Engineering, offers universal, in-line applications wherever caustic and/or corrosive liquids or gases are handled.

Dumont says the unit can be employed in petroleum and chemical processing as a filter for instrument and gaging points; it can be used with nearly all elements and blends; it has been in service with gases to 2250 psi and will withstand temperature extremes from —350 degrees F to +500 degrees F.

The unit is made entirely of stainless steel, except for an enclosed, chemically inert teflon washer which seals the two halves of the body

Circle Reply Card No. 27 →



how ROBINSON *Vibration and Shock Control*

PROTECTS PERFORMANCE and assures RELIABILITY in Shipboard Installations . . .

Robinson has pioneered in the development and production of all-metal, low frequency vibration ***and*** shock mounting systems for the Navy's latest communications, radar, sonar and electronic computing equipment.

These are the **first all-metal environmental control systems** to be accepted by the Navy, and many are already in service aboard the latest missile cruisers, destroyers, aircraft carriers and nuclear submarines throughout the fleet.

Front View   Rear View

This is Robinson Model W664-3 with the Collins AN/URC-32 single sideband shipboard transceiver installed. This all-metal mounting system includes a heavy duty, dual stage base and a stabilizer unit which is mounted on the rear of the equipment.

Exclusive dual stage concept and highly damped MET-L-FLEX® resilient cushions assure the full range of vibration isolation and shock attenuation—double protection for extra reliability! *Send for FREE brochures.*

ROBINSON VIBRASHOCK DIVISION
Vibration and Shock Control
ROBINSON *Aviation Products, Inc.* TETERBORO, NEW JERSEY

DESIGNERS AND MANUFACTURERS OF VIBRATION CONTROL SYSTEMS

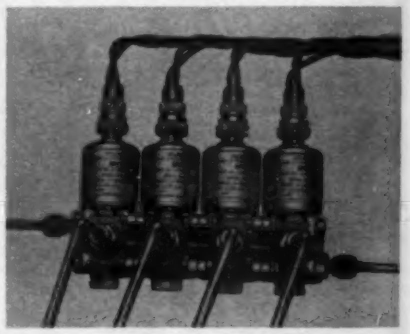
together. Filter element is a woven, wire mesh screen. Assembly is available in standard sizes to fit ¼ in. and ⅜ in. tube sizes. The design gives maximum flow providing 1.2 sq. in. of filter surface.

Circle Reply Card No. 104

Valve Features Balanced Poppet

A pneumatic/hydraulic, self-manifolding valve, made by Marotta Valve Corp. for system designing and multiple valve applications, is basically a 3-way, 2-position, N. C. or N. O., magnetic or manual operated valve.

This MV-74MM "Building Block" features a balanced poppet moving between two soft, bubble-tight seats and a symmetrical body. A single valve can be used in a one valve application or it can be manifolded into any number of valves, depending on the intended end use. Each valve has two in-line ports and a third port perpendicular to them; the poppet is centrally located between ports.



Balanced poppet design allows pressure to be applied to either or both sides of the valve.

Modular design concept of the unit makes it suitable for designing and building systems, "breadboard arrangements," system sequencing, and test set ups.

Operating pressure at all ports is 0-3000 psig, with special models 0-6000 psig. Proof pressure is 4500 psig and burst pressure 7500 psig. Magnetic actuated valves operate on either a 18-29 VDC coil or 100-125 VAC coil.

Circle Reply Card No. 105

Reduction Gear Has 16.25 to 1 Ratio

High speed reduction gear furnished with Model 720 engine contains components which will fulfill operating requirements of Model 720 generator set. The gear is a product of General Electric Medium Steam Turbine, Generator and Gear Dept.

The gear ratio of 16.25 to 1 accepts 19,500 rpm output shaft speed

of the engine and reduces it to 1200 rpm for generator set.

Flexible couplings of the gear torsionally isolate engine from the gear, and in turn, the gear from generator load. Flexible coupling on high speed shaft is balanced for high speed, assuring positive gear alignment. The high speed and low speed gear reductions are both of helical design. Reduction gear drives a lube service and scavenge pump. Force-feed lubrication passages are machined into gear casing to keep external piping to a minimum.

Circle Reply Card No. 106

NAVCOR Develops Module Test Set

A completely self-contained instrument, which provides standardized test signals for verifying correct operation of all NAVCOR transistorized digital system modules, has been developed by Navigation Computer Corp.

The Model 1300B Universal Module Test Set generates three standardized waveforms necessary for checking the modules. It provides all supply voltages, variable loads, and controls necessary for sensitivity, margin, and frequency checking.

A single-pulse generator and output monitor meter eliminate the need for an oscilloscope during most checks. However, a monitor output is provided to facilitate rise time measurements.

Circle Reply Card No. 107

Triple Diffused Mesa Transistor

A silicon power transistor has been manufactured by Pacific Semiconductors, Inc. The triple diffused mesa transistor, PT530, is described as a "medium power VHF communications transistor," although its low saturation resistance indicates possibilities in switching applications.

Unit has a power output of 5 watts at 30 Mc/s with a power gain of 10 db minimum at collector voltage of 28 v. The PT530 delivers oscillator power to 200 Mc/s. It is housed in a TO-8 industry standard package.

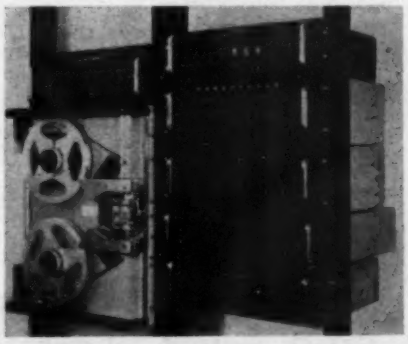
Physical structure of the transistor is an n-p-n-n+ configuration. Line emitter, dual base contacts, and low collector region resistance result in a device optimized for VHF power operation.

According to manufacturer, PT530 will perform as a transmitter final amplifier stage or as a driver for PSI type PT901 high frequency transistor.

Circle Reply Card No. 108

Digital Data System

A fully transistorized digital data system, smallest ever constructed, has been delivered to U.S. Navy Underwater Sound Laboratory, New London, Conn., by Communications Control Corp.



Intended for shipboard use, the system records data on magnetic tape at high speed with an accuracy of 0.1 per cent. It is then processed and reduced in a companion electronic computer.

The system features multiple channel input, portability, and fully transistorized circuitry.

Circle Reply Card No. 109

Ceramic for Radome

A low loss, high strength, vacuum tight, 99.5 per cent aluminum oxide ceramic with superior dielectric loss characteristics is being produced by Coors Porcelain Co.

The material, Coors Type AD-995, was developed originally for radome applications. It has a loss tangent at room temperature of 5.9 by 10^{-5} at 9200 Mc/s. With a dielectric constant of 9.27, the loss factor at room temperature is 5.5 by 10^{-4} at 9200 Mc/s.

According to Coors, the material has a flexural strength of 28,900 psi at 2000 degrees F and 15,300 psi at 2500 degrees F. Maximum working temperature of the ceramic is 3200 degrees F. Its specific gravity is 3.8 and it is rated at 9 on Moh's Scale and 80 on Rockwell 45 N scale.

Circle Reply Card No. 110

new UE literature

Data Sheets Released On Plug-in Cards

Data sheets have been released on a variety of transistorized plug-in cards which can be used to implement large systems containing dynamic and static type digital logic, as well as analog computation section. Developed by General Applied Science Laboratories, Inc., the cards are designed so that conversion from one type of computation system to another can be accomplished using only standard cards, and without additional special circuits.

The high speed flip flop, dual medium speed flip flop, digital gate, delay multivibrators, nixie driver, and blocking oscillator are used primarily for static computing circuits. By use of NOR logic and auxiliary gates on other cards, a system complete with timing units and output displays can be constructed.

The clock oscillator, clock pulse amplifier, active element, delay line card, computer gate card, and magnetostrictive delay line are used to implement dynamic circuit systems. The basic card (active element) contains an AND, OR, AND diode gating pyramid and an amplifying and reshaping section. The multiplexer gate, summing amplifiers, and servo amplifier are for a complete analog computing system, or can feed a digital system through an analog-to-digital converter.

Circle Reply Card No. 126

ASW Directory Service

An Anti-Submarine Warfare Technical/Management Directory Service, giving lists of where to go and whom to see in Navy, has been compiled by Undersea Technology Dept., Defense Information, Inc.

Revised quarterly — or in event of major personnel or organizational changes with the Chief of Naval Operations, Office of Naval Research, or Bureau of Naval Weapons and Bureau of Ships — the service lists technical, functional, or operational responsibilities of more than 300 desks in Washington concerned with undersea technology. A locator gives Navy code designation, room, and telephone number.

Circle Reply Card No. 127

Microwave Measurements Given in Booklet Form

A 100-page application note presenting basic information on microwave measurements is available from Hewlett-Packard Co. The note, in booklet form, is entitled "Introduction to Microwave Measurements."

Booklet presents general background information on microwaves and discusses microwave transmission theory, basic microwave measurements, and equipment used in making them. It also presents eight basic experiments.

Appendix material includes a glossary of microwave terms and data sheets on various measuring equipment.

Circle Reply Card No. 128

TO OUR READERS

MANY OF OUR READERS HAVE BEEN REQUESTING BACK ISSUES OF UE MAGAZINE. WE REGRET THAT DUE TO THE LARGE DEMAND FOR PRIOR ISSUES AND THE RAPID INCREASE IN OUR CIRCULATION, OUR SUPPLY OF BACK ISSUES IS COMPLETELY EXHAUSTED.

Sheffield Publishing Co., Inc.

Russian Ultrasonics Book Translated

"Ultrasonics and Its Industrial Applications," a new book by O. I. Babikov, is translated from Russian and published by Consultants Bureau.

The volume covers Soviet advances in this field, including ultrasonic control methods, the action of high-intensity oscillations on various technological processes, drilling techniques, and pulse methods of flaw detection and physicochemical research.

Fundamental physical principles are presented in concise form.

Circle Reply Card No. 129

Flame-Cutting Machines

A 28-page catalog describing Oxweld flame-cutting machines is available from Linde Co., division of Union Carbide Corp.

Specifications for each machine, illustrations of typical installations, and description of machine accessories are included. Linde's new photocell tracer is also described. This unit reproduces complicated metal parts from exact size pencil or ink drawings.

Circle Reply Card No. 130

Bulletin Describes Push Button Switch

A combination miniature indicator light and push button switch that has application in computers, data processing, industrial control, or signal systems is discussed in Bulletin 69 of Transistor Electronics Corporation.

Dimensional diagrams and optional electrical connection arrangements for Type A and Type B models are shown. Specifications are listed for eight different incandescent and three neon type lamps available in this "Tec-Lite" MBL series.

Also included in catalog are color options for flat top lenses, terminal data, switch contact information, and specifications on internally mounted series resistors. Applicable military and federal specifications are listed.

Circle Reply Card No. 131

Steel Flange Catalog

A catalog of drop forged steel flanges has been released by Harrisburg Steel Co. It contains specifications for 150-pound to 1500-pound drop-forged steel flanges and welding neck flanges.

Charts relate pertinent dimensions such as pipe size, hub diameter, size and number of bolts, etc. to the 150-pound, 300-pound, 400-pound, 600-pound, 900-pound, and 1500-pound flanges. Information on typical flange facings and drilling templates is included.

Circle Reply Card No. 132

Corrosion Slide Rule

A 4 in. by 8 in. card that works like a slide rule and tells how each of eight types of metal withstands corrosive effects of 141 chemical agents, has been developed by The H. M. Harper Co.

This miniature computer tells how each of the eight metals will react to a particular agent; excellent, good, fair, or not good. Designed as a guide, the computer notes some variations of corrosion with footnotes on the card face keyed to numbers on the color-coded notes about agent-metal combinations, and to other numbers with the agents.

The metals are common in mechanical work — brass and naval bronze; silicon bronze; monel metal; stainless types 410, 416, and 430; stainless types 302, 303, 304, and 305; stainless type 316; copper, and aluminum.

Circle Reply Card No. 133

Technical Reprint Shows Hydraulic System Details

A technical reprint, showing schematics, details, and applications on their six channel hydraulic force control system, has been released by Gilmore Industries, Inc.

Used for static and dynamic loading test stands, the system is designed for up to 100,000 pounds force capacity per cylinder, and includes a load cell in series with each cylinder to provide force feedback component to the console.

Circle Reply Card No. 134

Temperature Scale Conversion Chart

A temperature conversion chart offered by Rosemount Engineering Co. permits rapid, accurate conversion of any scale — Kelvin, Rankin, Centigrade, or Fahrenheit — to any other scale.

Range is from absolute zero to 16,000 degrees C. Accuracy of rulings is approximately 0.01 degrees below 100 degrees C; 0.02 degrees up to 300 degrees C; 0.05 degrees up to 800 degrees C; 0.2 degrees up to 2000 C; 1 degree up to 6000 degrees C; and 5 degrees up to 16,000 degrees C.

Chart is printed on both sides of single durable sheet, 8.5 in. by 11 in., punched for 3-ring binder.

Circle Reply Card No. 135

u e people and employment

Lord Manufacturing Co. recently announced the appointment of **Lindsey M. Hobbs,** specialist in exploration and development of polymers, as manager of central research. **Mr. Hobbs** was formerly with Air Reduction Co., Inc. as assistant director of chemical research.

John Basarab, Jr., who joined Lockheed Electronics Co. four years ago as a design engineer, has been named supervisory engineer in that company's Shipboard Electronics Dept., Military Systems Div. Before joining Lockheed Electronics, **Mr. Basarab** served as an electrical engineer at Charham Electronics.

Manager of the newly established New London District Office of General Electric Co.'s Heavy Military

JOHNSON

HOBBS

Electronics Dept. is **Richard B. Southwell.** Since joining GE in 1956, **Mr. Southwell** has been a system planning engineer for undersea warfare in the product planning organization of the same Dept.

Richard C. Johnson has been appointed manager of new programs at Washington Technological Associates. **Mr. Johnson** comes to WTA after seven years with Navy's BuShips.

Two former Navy scientists have joined the Washington, D.C. research staff of Electro Nuclear Systems Corp. They are **Edwin G. Savasten** and **Masaru Shimoda,** both formerly with the David Taylor Model Basin, a United States Navy research facility in Washington.

Dr. Alva C. Todd, a specialist in electronic instrumentation, has joined The Hallicrafters Co. as director of applied research for military products. In his new position, **Dr. Todd** will head a group primarily

responsible for developing military products with future market potential. **Dr. Todd** was previously a staff member at the Illinois Institute of Technology's Armour Research Foundation.

United Technology Corp. has named six top scientists and engineers to direct operations at its new Development Center near Morgan Hill, Calif. Directing work at the Center will be **Eugene Roberts,** assistant director of UTC's Operations Div. Assisting him will be **Dr. Aaron Rose,** former director of the Texas Engineering Experiment Station at Texas A&M College. Heading the Propellant Processing Branch will be **Stanley Warren**, previously vice president of Grand Central Rocket Co. **Dr. Francis J. Lavacot,** once director of research and development for McCormick-Selph Associates, will head quality control and reliability. In addition, **Phillip A. Peller,** formerly president of the AstraVac Corp., will head the Plant Engineering Branch of the firm. **W. D. Van Patten** will direct testing operations. Before coming to UTC, **Mr. Van Patten** was with Space Technology Laboratories, Inc.

George P. Whitbread has been appointed to the newly created position of product manager, insulating materials, at Telecomputing Corp.'s Narmco Industries Materials Div. **Mr. Whitbread** comes to this post from the corporation's Electronic Components Div. where he was chief chemist. In his new position he will direct laboratory efforts in the formulation of new and advanced insulating compounds, as well as planning and marketing of insulating materials.

Appointment of **Robert L. Eichberg** as system program manager in Stromberg-Carlson's Electronics Div. has been reported. In this capacity, **Mr. Eichberg** will have specific responsibilities in the field of antisubmarine warfare and related areas. He comes to Stromberg-Carlson from the Research and Advanced Development Div. of Avco Corp.

EICHBERG

WILKINSON

where he was assistant to the vice president. Another new appointment at Stromberg-Carlson is that of **H. Malcolm Wilkinson** who was made manager of the data acquisition and logging section, also in the Electronics Div. **Mr. Wilkinson** came to the company from Epsco, Inc.

The new works manager at Rheem Semiconductor Corp. is **Edward J. Quirk** who will direct manufacturing, manufacturing services, and quality control. Before coming to Rheem, **Mr. Quirk** was plant manager in charge of manufacturing and engineering at the CBS-Hytron, Lowell plant.

Bernard Luskin, manager of data processing for Westrex Corp., will direct the corporation's new Geophysical and Oceanographic Instrumentation Laboratory, headquartered in New York City. **Mr. Luskin** has been a consultant in geophysical instrumentation with Westrex since 1956.

U. S. Sonics Corp. has announced the appointment of **Stanley Miller** as manager of manufacturing. **Mr. Miller** will be responsible for the specialized manufacture of custom items and also for the volume production of various longer run product lines. **Mr. Miller** was formerly manager of manufacturing at the Puritan Aerosol Corp. At the same time, **George D. Buchler** was named plant manager of U.S. Sonic Corp.'s Cambridge and Somerville facilities. **Mr. Buchler** was previously the corporation's production manager.

Thomas M. Robertson has been named manager of anti-submarine warfare planning at Vitro Laboratories. **Mr. Robertson** moves to his new assignment from within the organization where his most recent position was that of director of the Laboratory's Systems Development Dept. Replacing Mr. Robertson as acting head of the Systems Development Dept. is **William L. Freienmuth. Mr. Freienmuth** continues in a dual capacity as assistant manager of the Technical Operations Office.

The addition of **Walter H. Michel** to the staff of Friede & Goldman, Inc., was recently announced by the firm's president. Prior to joining the Friede & Goldman organization, **Mr. Michel** was chief engineer with American Marine Corp. where he was in charge of the design and production of all types of ocean-going and river marine equipment.

The new Sanders Burlington Advanced Systems Laboratories is being managed by three key engineering executives from the company's staff in **Nashua, New Hampshire. Ethridge C. Best** is manager of advanced weapon systems planning. **Russell B. Hawes** serves as manager of operations, and **Kenneth Dollinger** is the manager of advanced development. **Mr. Best** came to Sanders Associates from Navy's Bureau of Aeronautics where he was director of the Electronics Div. **Mr. Hawes** and **Mr. Dollinger** have been with the company since 1952. In addition, **Lloyd E. St. Jean** was named general manager of Sanders' new facility on Long Island. Prior to his new responsibility, **Mr. St. Jean** held the position of chief engineer in the Equipment Design Dept.

underwater engineering

ADVERTISING OFFICE
640 Washington Bldg.
Washington 5, D. C.
District 7-8570

Shirley McIntosh
Advertising Production Manager

★ ★ ★

REPRESENTATIVES

Davis & Sons
30 N. LaSalle Street
Chicago 2, Illinois
FRanklin 2-9052

W. J. Martin & Co.
56 West 45th St.
New York 36, New York
YUkon 6-0636

Albert W. Randle & Associates
2404 W. Seventh Street
Los Angeles 57, California
DUnkirk 2-8980

John Printup & Associates
1006 Langford Building
Miami 32, Florida
FRanklin 9-2668

John Printup & Associates
2607 Millmar Drive
Dallas 28, Texas
DAvis 1-0898

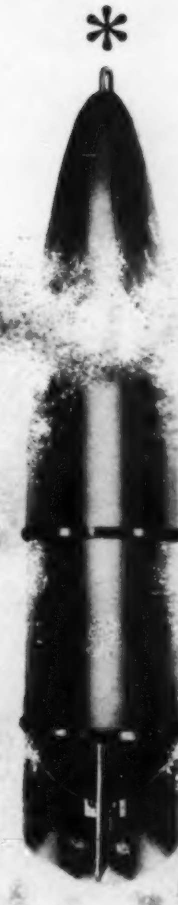
★ ★ ★

ALL ADVERTISING SUBJECT
TO EDITORIAL APPROVAL
PUBLISHED BY
Sheffield Publishing Company
640 Washington Building
Washington 5, D. C.
Telephone: District 7-8570

Advertisers Index

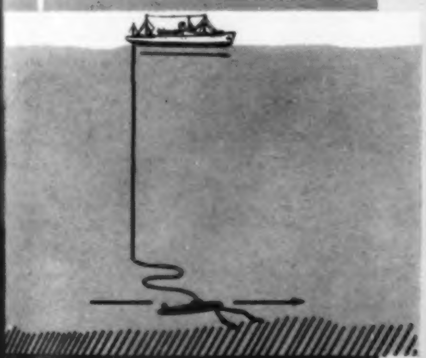
NOTE—Underwater Engineering circulation is executed on a controlled unpaid basis. Engineering and management personnel actively engaged in the areas of undersea warfare and oceanography are considered qualified applicants. Use the self-addressed post card in this issue or write to Circulation Dept., 2775 S. Moreland Blvd., Cleveland, Ohio.

USI Reports on

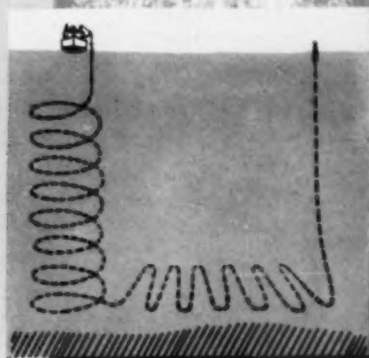


Five current projects on MECHANICAL EQUIPMENT for oceanographic research

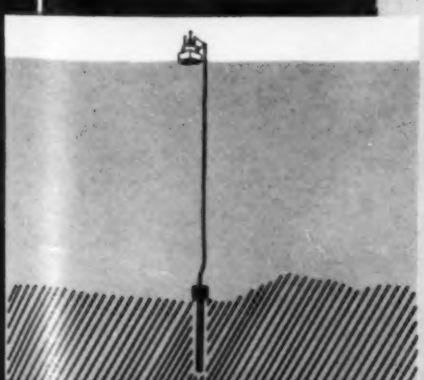
***FOIF—Free Oceanographic Instrument Float.** Now undergoing deep sea testing, this float follows a free flight trajectory to the depths and return. By freeing the instrumentation from its connection to the mother ship, data gathering is far more efficient and faster.



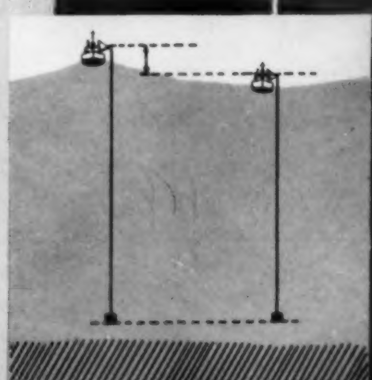
GRAPPLING SYSTEMS. A self contained, self propelled, remotely controlled grappling device for ocean floor work. Utilizing closed circuit television and light arrays, the oceanographer can search out and gather samples selectively with this mechanical hand. Also, suitable for attachment to bathyscaphes and deep diving submarines.



DUMS–DEEP UNMANNED SUBMERSIBLES. A new self propelled, deep diving unmanned submersible which follows a pre-set course to any depth for durations of four hours. Consisting of a fiber glass case and self contained jet drive power package, DUMS will collect data throughout large volumes of the ocean.



DEEP CORING DEVICE. Using a new principle in coring, this deep self powered corer can obtain long undisturbed cores of the basin sediments. Dropped freely, or cable lowered, the corer will level itself, collect a 200 ft. sample from one location in a vertical direction, and then return to the surface.



CONSTANT TENSION WINCHES. This research winch holds a constant tension in the cable thus eliminating tension and depth fluctuations caused by ship reaction to wave motion. By utilizing a new servo controlled hydrostatic drive, cable breakage and depth holding problems are minimized.

* * *

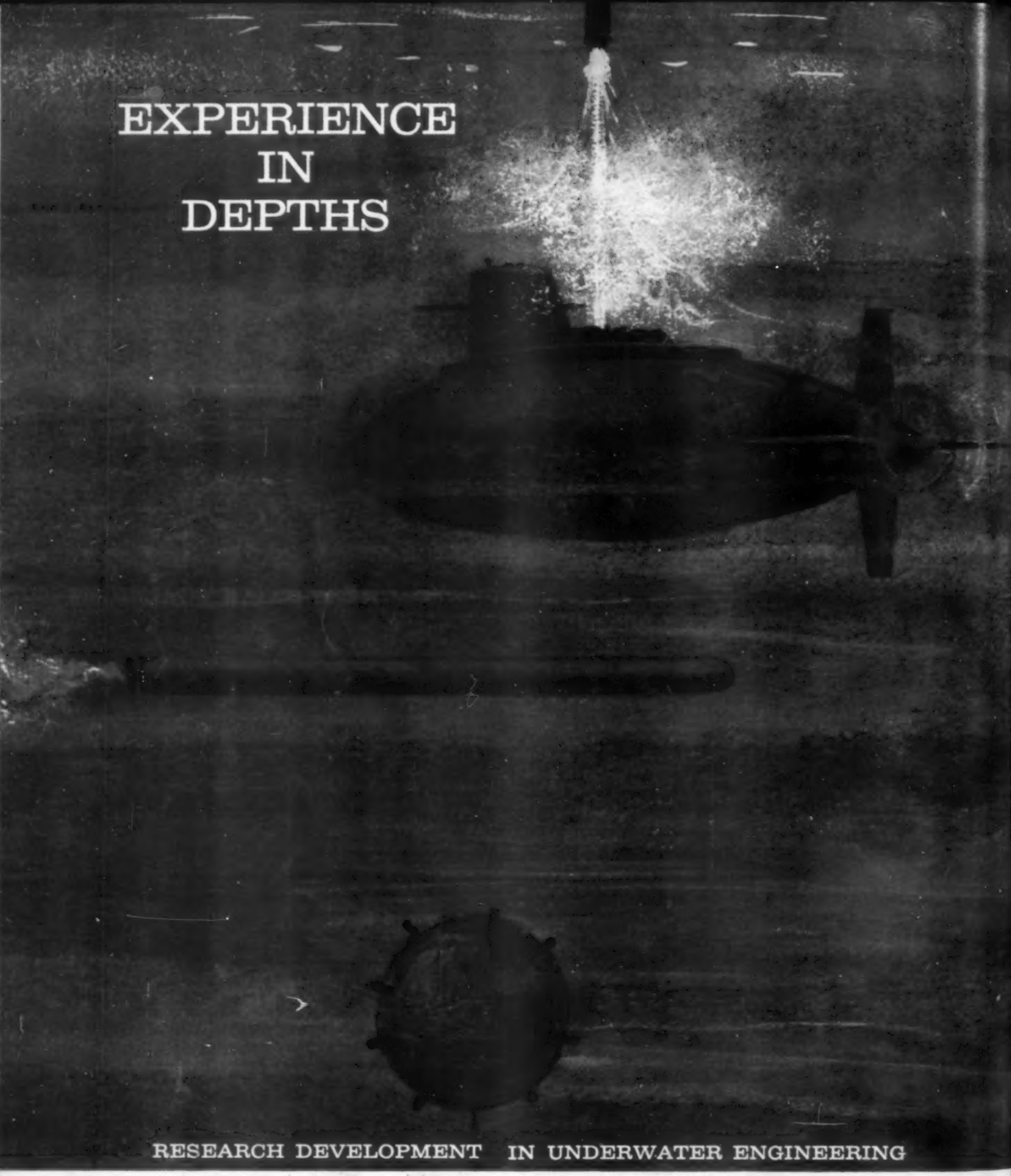
Components for Bathyscaphes and Deep Diving Submarines • Deep, Fiber Glass Floats • Fiber Glass Pressure Cases for A.S.W. and Oceanographic Research

For information on career opportunities write

DEPARTMENT OF MARINE TECHNOLOGY

USI Technical Center

Pompano Beach, Florida


EXPERIENCE
IN
DEPTHS
RESEARCH DEVELOPMENT IN UNDERWATER ENGINEERING